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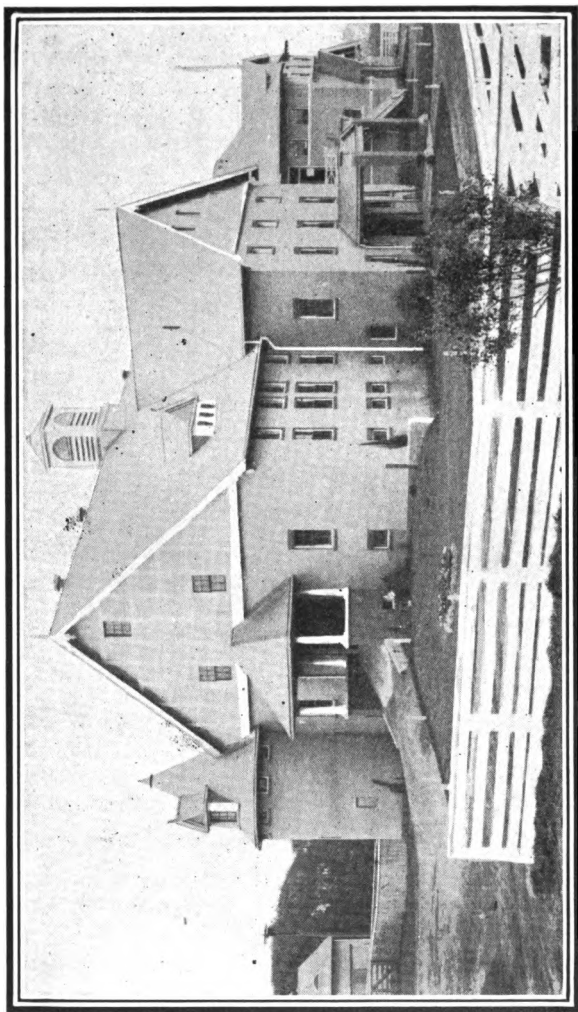


FIG. I—MODEL BARN OF THE IOWA EXPERIMENT STATION (SHOWING ROUND SILO)
(Photographed by Stayner)

Rural School Agriculture

EXERCISES FOR USE WITH ANY TEXT-BOOK
OF AGRICULTURE, OR WITHOUT
A TEXT-BOOK



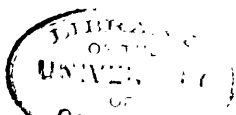
BY

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I L L U S T R A T E D

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1907



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GENERAL

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TO
THE MEMORY OF MY BROTHER,
W. A. D.
IN REMEMBRANCE OF OUR BOYHOOD DAYS
ON THE FARM

166727

PREFACE

In the preparation of this little book two classes of students have been considered by the author. First, there are those who expect to become teachers in rural schools where agriculture is required, and who have had little training in agriculture, not only in the subject matter, but in methods of presenting the subject to students. This book then is designed in part for the training of teachers in normal and summer schools. The greatest barrier in the progress of agricultural education in rural schools is the lack of thoroughly trained teachers in agriculture. Secondly, there are those in rural districts, the majority of whom will continue to live upon the farm, and whose minds should be awakened to the fact that the problems of the farm are great enough to enlist all the brain power they can summon. Let us once establish in the mind of the farm boy an intellectual insight into the problems of the farm, and the ever increasing exodus of the most enterprising young men of our rural districts to the city will be checked.

This book is a manual of exercises covering many phases of agriculture. Feeling that in many instances the so-called nature study has been largely sentimental and urban in its leanings, the exercises have been prepared with a view to enlist the interest of the boys of the farm. The successful farmer of the future must be an experimenter in a small way. This work should begin in the public schools. Students should be taught to think, and to

work out some of the principles of scientific agriculture. If an experiment helps the pupil to think, or makes his conceptions clearer, then it fills a useful purpose.

The French minister of education, in giving instructions "to assist the masters of rural elementary schools in teaching the first rudiments of agriculture," says: "Instruction in the elementary principles of agriculture, such as can be properly included in the program of primary schools, ought to be addressed less to the memory than to the intelligence of the children. It should be based on the observations of the every-day facts of rural life, and on a system of simple experiments appropriate to the resources of the school and calculated to bring out clearly the fundamental, scientific principles underlying the most important agricultural operations. Above all, the pupils of the primary school should be taught the reasons for these operations, and the explanations of the phenomena which accompany them."

The author desires to acknowledge especial obligations to Prof. C. H. Mathes, of Maryville College, for reading the proof of the whole book and for valuable criticisms; to Mr. B. F. Williamson, for many new drawings. Thanks are due to many others for illustrations used, for which special credit is given as they appear. His thanks are also due to Prof. J. M. Johnson, of the University of Georgia, for many valuable suggestions.

CHARLES W. DAVIS.

DAHLONEGA, GA., 1907.

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Rural School Agriculture

EXERCISE 1

CONDITIONS OF MATTER

TIME: FALL OR SPRING TERM

Object: To learn the three conditions of matter.

Material needed: Three tumblers, one-half pint flour, water, pencil.

DIRECTIONS

Place upon the table three tumblers; half fill one with flour; another with water; and leave the third containing only air. Push a pencil into each and remove it. Note the difference in the results.

How do you account for this difference?

Can you find the surface of the contents of each tumbler?

From this experiment we can derive three definitions upon the condition of matter:

1. Matter whose particles are not free to move among themselves is said to be solid.
2. Matter whose particles are free to move among themselves and which has a definite surface is said to be liquid.
3. Matter whose particles are free to move among themselves and which has no definite surface is said to be gas.

QUESTIONS

1. Could matter exist except in one of the three forms mentioned above?
2. Which of the three is the commonest form of matter?
3. Can you name a substance which may be converted from one form to another?

Facts.—Plants take food from the air in a gaseous form. We usually apply plant food to the soil in a solid form, but it cannot be taken up by plants until it is changed to a liquid form. Most animals take solids as food.

EXERCISE 2

THE TWO CHANGES IN MATTER

TIME: FALL OR SPRING TERM

Object: To learn the difference between a physical and a chemical change.

Material needed: Tumblers, salt, piece of glass, copper coin, nitric acid.

DIRECTIONS

1. Put a small amount of salt in a tumbler; add water and stir until it is dissolved. Put a few drops of this solution on a piece of glass and heat gently

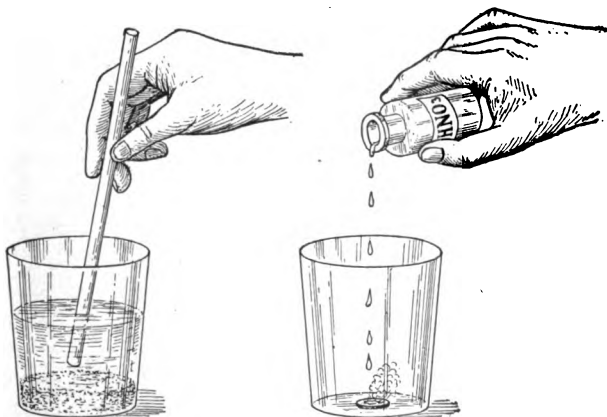


FIG. 2—CHANGES IN MATTER

PHYSICAL CHANGE (AT LEFT)

CHEMICAL CHANGE (AT RIGHT)

until it becomes dry. What have you remaining on the glass? Taste the substance.

2. Place a copper coin in a tumbler and add a few drops of nitric acid. What takes place? Notice the color of this new solution. Pour a few drops of this solution on a piece of glass and dry as before. In which case is there a new substance formed?

A chemical change results in a new substance.

A physical change does not result in a new substance.

State the kind of change in each of the following:

1. The burning of lime.
2. The slaking of lime.
3. The rusting of iron.
4. The melting of ice.
5. The freezing of water.
6. The baking of bread.
7. The souring of milk.

EXERCISE 3

HOW PARTICLES OF MATTER ARE HELD TOGETHER

TIME: FALL OR SPRING TERM

Object: To learn the difference between adhesion and cohesion.

Material needed: Putty or chewing gum.

DIRECTIONS

Press a piece of putty or chewing gum against the wall, and leave it there.

What prevents its falling?

We call the force that holds the putty against the wall adhesion. Compare the particles of putty with the particles of the wall.

We call the force that holds the particles of putty together cohesion.

We now have two other definitions in regard to the properties of matter:

Adhesion is the force that holds unlike particles together.

Cohesion is the force that holds like particles together.

QUESTIONS

What force causes the following:

1. Soil particles to stick together?
2. A piece of rope to resist breaking?

3. Two pieces of steel to stick when welded?
 4. Plastering to remain on the wall?
 5. A sponge to take up water?
 6. A bow to spring back after being bent?
- Does heat affect adhesion and cohesion?

EXERCISE 4

CONDENSATION

TIME: FALL OR SPRING TERM

Object: To learn the meaning of condensation.

Material needed: Water, teakettle, piece of glass.

DIRECTIONS

Boil some water and allow the escaping steam to come in contact with a cold slate or piece of glass; notice the formation on the slate.

What is it?

Which is cooler, the slate or the vapor?

What difference would be noticed if the slate should be very hot?

Facts.—Condensation is changing a vapor into a liquid. A liquid takes in heat when it vaporizes, but when a vapor condenses, it gives up heat.

QUESTIONS

1. What happens when we breathe into cold air?
2. Does sprinkling the floor in very warm weather make the room more comfortable?
3. Why does moisture appear on the outside of a pitcher of cold water upon a summer day?
4. How are fog, cloud, snow, and rain formed?
5. Why do we sometimes put water into a cellar when there is fear that the vegetables may freeze?

EXERCISE 5

ABSORPTION

TIME: FALL OR SPRING TERM

Object: To study the nature of an absorbent.

Material needed: Charcoal, broken stone, cotton batting, round bottle, vinegar.

DIRECTIONS

1. Put a piece of freshly burned charcoal under water and observe what collects on the surface of the charcoal. What is it? Where did it come from? What caused it to come to the surface?

2. Hold a piece of freshly broken stone under water in the same way. Do you get the same result? Why?

Charcoal is porous and absorbs air and other gases.

3. Break the bottom out of a round bottle, invert it and insert into the base of the neck a small bit of cotton. Fill to a height of 2 inches with powdered charcoal, and pour into the bottle some vinegar; catch what filters through in a vessel and compare the color of the filtered with that of the unfiltered vinegar.

QUESTIONS

1. How has the charcoal changed the color?
2. Why is charcoal valuable for filtering?

3. What other substances may be used as a filter?
4. Why is spring water so clear?
5. Is the soil, under field conditions, an absorbent?
6. Logs which have been in water for a long time sometimes sink. Can you explain this?

EXERCISE 6

ABSORPTION (Continued)

TIME: FALL OR SPRING TERM

Object: To study other examples of absorption.

Material needed: *Flower pot, salt, two tumblers, beans.*

DIRECTIONS

1. Close the hole in an ordinary flower pot, put some water in it and throw in a handful of salt. After a day or two what do you observe on the outside of the pot and what do you think is the reason for the change?

2. Fill a rather thin bottle with peas or beans; leave unstoppered and place the bottle under water for several days. What happens? Give the cause for this result.

3. Into a tumbler containing a very strong salt solution put a handful of beans. Put a handful of beans into another tumbler containing only fresh water. After three days observe and note which lot is swollen more. How did the salt solution affect the amount of water absorbed?

EXERCISE 7

EVAPORATION

TIME: FALL OR SPRING TERM

Object: To study the conditions which influence evaporation.

Material needed: Tin can, tumbler, shallow dish.

DIRECTIONS

1. Put a cup of water upon the stove, but do not let it boil. Is there anything passing from the water into the air? What is it? Does it come from the surface or from below?

Heat the water until it boils. What do you now see coming from the water? Is it formed at the surface or below the surface? Can you now distinguish between evaporation and boiling?

2. Put like quantities of water into a narrow-necked bottle, a tumbler, and a shallow dish. Which evaporates the most quickly? Which most slowly? Account for this difference.

3. Moisten a slate and observe how quickly it dries. Moisten the surface of the slate again and fan the air with it. Is there any difference in the rapidity of evaporation?

4. Moisten the slate again and hold over a lamp or a stove; notice if there is a still greater difference in drying. Can you explain this?

Summarize the conditions which affect the rapidity of evaporation by filling the blanks below.

The.....the extent of surface, the
.....the rapidity of evaporation.

The motion of the air.....the rapidity of evaporation.

An increase in the temperature of the air.....
the rapidity of evaporation.

Evaporation will be.....rapid when
the air is dry than when it is moist.

QUESTIONS

1. What kind of weather is most favorable for rapid evaporation?

2. Why do the blades of corn curl up during dry weather?

3. Would level culture or ridge cultivation cause a soil to lose the more moisture? Why?

EXERCISE 8

COMPOSITION OF THE ATMOSPHERE

TIME: WHENEVER CONVENIENT

Object: To represent graphically the percentage of the various constituents of the atmosphere.

Material needed: Paper and pencil.

COMPOSITION OF THE ATMOSPHERE

Oxygen	20.60 per cent.
Nitrogen	77.18 per cent.
Water vapor.....	1.40 per cent.
Carbon dioxide.....	.04 per cent.
Argon .....	.78 per cent.

DIRECTIONS

With diagram in Exercise 108 as a model, construct a diagram showing graphically the composition of the atmosphere.

Facts.—Besides the substances named above, we should name ammonia, nitric acid, and ozone (an active form of oxygen). Ninety-seven per cent. of all materials which are built into the tissues of plants comes from the atmosphere. Only a small portion comes from the soil.

EXERCISE 9

PROPERTIES OF CARBON DIOXIDE

TIME: FALL OR SPRING TERM

Object: To learn by simple experiments some of the properties of carbon dioxide.

Material needed: Mason jar, candle, wire, lime-water, marble chips, rubber tube, tumbler, hydrochloric acid.

DIRECTIONS

1. Mount a piece of candle on a J-shaped wire and lower it into a quart Mason jar.

What is in the jar besides air?

2. Put some chips of marble into the jar and cover with water; add a sufficient amount of hydrochloric acid to keep up a vigorous chemical action for a while. Carbon dioxide is being formed, as shown by the effervescence.

Lower the candle slowly into the jar.

What happens?

Will carbon dioxide support combustion?

Will air support combustion?

Lower, by means of a string, a small beaker of lime-water and observe what happens. This is caused by the carbon dioxide uniting with the lime to form calcium carbonate.

3. Pour more hydrochloric acid into the jar until chemical action again becomes vigorous; place one

end of a rubber tube in the jar and suck the other end; when you taste the carbon dioxide (it is not poisonous) lower the outer end of the tube into a tumbler. Pour the contents of the tumbler upon a candle flame.

How does it affect the flame?

What kind of taste does carbon dioxide have?

Why is it wise to lower a lighted candle into the bottom of an unused well or mine?

In what respect is carbon dioxide like water?

How do plants purify the air?

How do animals and plants differ with respect to carbon dioxide?

EXERCISE 10

ASSIMILATION AND RESPIRATION

TIME: FALL OR SPRING TERM

Object: To learn the difference between assimilation and respiration.

Material needed: Note-book, pencil.

DIRECTIONS

Observe the contrast between assimilation and respiration given below. Notice that one is substantially opposite to the other. This table is taken from Goodale's *Physiological Botany*.

Assimilation Proper	Respiration
Takes place only in cells containing chlorophyll. Requires light. Carbonic acid absorbed, oxygen set free. Carbohydrates formed. (Energy is stored.) The plant gains in dry weight.	Takes place in all active cells. Can proceed in darkness. Oxygen absorbed, carbonic acid set free. Carbohydrates consumed. (Energy is brought into use.) The plant loses dry weight.

EXERCISE 11

PLANTS SELECTING THEIR FOOD

TIME: FALL OR SPRING TERM

Object: To show artificially how plants may select their food.

Material needed: Bluestone, three earthenware cups, three lamp chimneys, zinc, red ink, salt, bladder.

DIRECTIONS

1. Prepare a strong solution of copper sulphate and place in an earthen or china cup or shallow dish. The solution is made by dissolving bluestone in water. Tie a piece of bladder around one end of a lamp chimney, partly fill with water, and set it in the glass containing the copper sulphate solution. Drop into the chimney a piece of zinc.

2. Prepare a second solution by dissolving eosin or red diamond dye in water. Red ink will do. Place in this solution a lamp chimney prepared as above with the pieces of zinc.

3. Prepare a third solution by dissolving common salt in water, and place in this another lamp chimney prepared as in the two cases above.

In the first condition, the copper sulphate is formed by the union of copper and sulphuric acid. The copper sulphate passes through the membrane, and when it comes in contact with the zinc a chemical

change takes place. The copper is separated from the sulphuric acid and is deposited on the zinc.

In the second condition, the eosin or coloring matter is not taken up by the zinc, but is taken up by the membrane, which is highly colored.

EXPLANATION

In the third condition, the salt in solution passes through the membrane and remains in its original

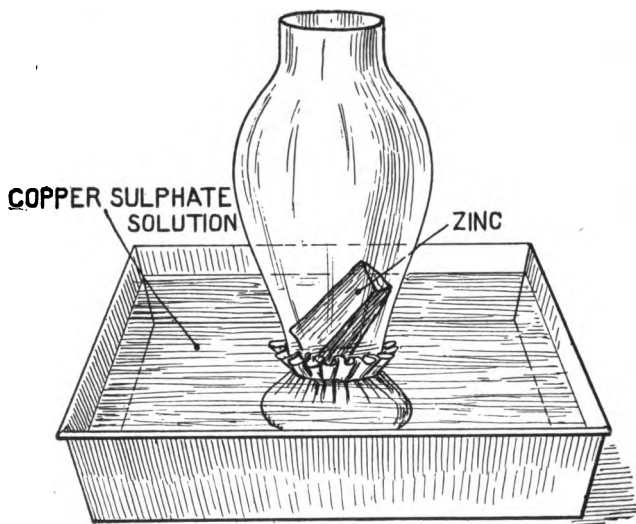


FIG. 3—CHEMICAL ACTION OF COPPER SULPHATE AND ZINC

strength. It is not taken up by the glass, the membrane, nor the metal. The passing of solutions through a membrane, as in this experiment, is called osmosis.

This experiment shows artificially how plants select their food by absorbing by osmosis certain elements to the partial or total exclusion of others. When a plant is grown in a solution of sodium nitrate, all of the nitrogen will be absorbed and utilized, while the sodium (unless it be a trace) is left in solution.

EXERCISE 12

THE NATURE OF SOLUTIONS

TIME: FALL TERM

Object: To learn the nature of solutions.

Material needed: Alcohol, camphor gum, shallow dish, tumblers, marbles, fine seeds, sugar, hot and cold water.

DIRECTIONS

1. Dissolve a bit of camphor gum in a small bottle of alcohol; pour a small part of this solution into a shallow dish and leave until the alcohol has evaporated. Observe that the camphor remains in the dish. We say the camphor has been dissolved, and explain this by supposing the camphor has been separated into particles too small to be seen, and that these tiny particles fit in between the particles of alcohol. Illustrate this by filling a glass with marbles; then pour small shot or fine seeds into the spaces between the marbles. By this we may understand also that water is porous.

2. Use two glasses; put some hot water into one, and cold water into the other. Into each glass put the same amount of sugar, stir rapidly, and notice that the sugar disappears first in the hot water. In the hot water the particles are farther apart, hence it has more pore space and can take up the sugar faster. Evaporate the water in one of the glasses to dryness and recover the dissolved sugar.

3. You will observe that a teakettle in which water is boiled usually becomes coated inside with a whitish or brownish deposit. Water contains certain amounts of mineral matter in solution, and when the water is evaporated from the kettle the mineral matter remains behind just as in the experiment with the camphor and sugar.

Facts.—Plants, unlike animals, cannot use solid food; it must be dissolved. Water dissolves plant food from the soil grains and carries it in solution to the various parts of the plant. This mineral matter in solution which is taken from the soil constitutes the ash of plants.

EXERCISE 13

EFFECT OF DIFFERENT AMOUNTS OF AIR UPON PLANT GROWTH

TIME: FROM APRIL UNTIL OCTOBER

Object: To find how decreasing the amount of air by excessive amounts of water affects the growth of plants.

Material needed: Five tumblers, seeds, soil, scales.

DIRECTIONS

Fill five tumblers almost full of rich soil and plant the same number of seeds in each. To the first add one-half teaspoonful of water each day; double the amount for each succeeding tumbler. After three weeks there should be a vast difference in the appearance of the young plants. Which plant seems to have done the best? Did the plant receiving the least amount of water suffer? If so, why?

Weigh the soil which seemed to have the right amount of water, dry thoroughly in a stove and weigh the dry soil. Calculate the per cent. of water.

Saturate with water the same soil used above; weigh, dry in a stove, and weigh again. Calculate the per cent. of water in the saturated soil. Compare the water-holding capacity of the soil with amount of water for best growth.



EXERCISE 14

PLANTS RESISTANT TO DROUTH

TIME: DURING WARM WEATHER

Object: To find some plants little affected by drouth.

Material needed: Potted cactus, houseleek, begonia, squash or cucumber.

DIRECTIONS

1. For this exercise select the following plants:

Prickly pear cactus.

Houseleek.

Begonia.

Squash or cucumber.

2. Let the plants be growing in pots and well rooted. Water the four plants and set them in a warm, sunny place. Observe every 24 hours, and when any plant begins to wilt, water and remove it. Keep a record of the time required for each plant to begin to wilt.

QUESTIONS

1. Why do some plants wilt sooner than others?
2. Do you think this is due in any way to the structure of the leaves?
3. What kind of soil or exposure is natural to each of the plants used in this exercise?

EXERCISE 15

THE EFFECT OF COLD ON PLANTS

TIME: DURING FREEZING WEATHER

Object: To determine the effect of cold on plants.

Material needed: Plant in pot, snow, potatoes, can.

DIRECTIONS

1. Place a pot plant in a cool place and apply snow to the soil in the pot for two or three days; use care so as not to allow the plant to freeze. Let the pot stand in a pan to catch the water formed by the melting of the snow. Why do the leaves wilt?

2. Expose some potatoes to the cold until they are frozen; divide in two lots, and place one lot in a can of water chilled by ice. Keep them in the can until the water reaches the temperature of the room. This should take several hours. Place the second lot near the fire so the potatoes may thaw quickly. Observe any differences in the appearance of the two lots.

3. Sprinkle some frosted plants with cold water and cover to protect them from the rays of the sun. Later, compare the treated with the untreated plants.

Facts.—In freezing, the cells are ruptured and the sap oozes out into the tissues; when the plant is thawed out slowly, the cells have time to re-absorb the sap. If the plant is thawed quickly, the sap can-

not be taken up and the plant will die ; then, too, if the thawing is done quickly the disorganized protoplasm cannot readjust itself.

Cold prevents the formation of chlorophyll or green coloring matter in the leaves, checks respiration, or the breathing process of plants, ruptures the cells, and produces chemical changes in the protoplasm of the cells. The most familiar change is the conversion of starch into sugar.

EXERCISE 16

ORGANIC AND INORGANIC MATTER

TIME: DURING THE WINTER

Object: To show that hay contains both organic and inorganic matter.

Material needed: Dry hay, shovel, piece of wire.

DIRECTIONS

Place some very dry hay in a shovel and heat on top of a good bed of coals. After a few minutes, if the contents are still black, break up the pieces with a wire and continue to heat until the charred remains become gray. The organic matter has now passed into the air, while the inorganic matter is left behind in the form of ash. The ash is mineral matter which the plant has taken from the soil.

The ash of plants contains the following ingredients: potash 2 to 8 per cent.; phosphoric acid 1 to 2 per cent.; and lime 30 to 35 per cent.

EXERCISE 17

MODES OF DISSEMINATING SEEDS

TIME: FALL OR SPRING TERM

Object: To classify plants according to their mode of disseminating seeds.

Material needed: Paper and pencil.

DIRECTIONS

Make a list of plants and place them in the columns below according to their means of disseminating their seed.

Wind	Water	Animals	Mechanical Contrivances	Artificial Means

EXERCISE 18

CLASSIFICATION OF PLANTS

TIME: WHENEVER CONVENIENT

Object: To classify plants of your section according to De Candolle's classification.

Material needed: Paper and pencil.

DIRECTIONS

De Candolle classifies the species of plants as shown below, also giving number of each. Find the number of plants of each group in your community and fill in the blanks in the following table:

Classification of Species	No. in World	No. in your Section
Cultivated for the underground parts.....	32	.....
Cultivated for the stems or leaves.....	65	.....
Cultivated for the flowers or their envelopes.....	4	.....
Cultivated for their fruits.....	77	.....
Cultivated for their seeds.....	64	.....
Cryptogam cultivated for whole plant....	1	.....

Write a list of each class.

EXERCISE 19

CLASSIFICATION OF PLANTS AS ANNUALS, BIENNIALS, AND PERENNIALS

TIME: WHENEVER CONVENIENT

Object: To classify plants with respect to their duration of life.

Material needed: *Paper and pencil.*

ANNUALS are herbs which spring from seed, blossom, mature their fruit and seed, and then die, root and all, the first season. They are fibrous rooted.

BIENNIALS grow the first season without blossoming, usually store up food in their roots, blossom and seed the following season, and then die completely.

PERENNIALS live and blossom year after year.

DIRECTIONS

From a list of plants furnished by the instructor, fill in blank columns below according to duration of life.

Annuals	Biennials	Perennials

EXERCISE 20

NATURE'S PLANTING OF SEEDS

TIME: WHEN GERMINATION BEGINS IN THE SPRING

Object: To determine Nature's depth and rate of planting seeds.

Material needed: Five shallow pans or boxes.

DIRECTIONS

1. Select a spot of ground which has not been disturbed for one season. Mark off a space 12 inches square and from this remove a layer of soil, 1 inch deep, and place in a shallow pan or box. Repeat the process until you have removed six layers of soil to a depth of 6 inches. Care must be taken so that the surrounding soil shall not fall into the excavation while the soil is being removed.

2. Label the pans and put in a warm place. Keep moist and wait for the seeds to germinate. As the seedlings appear above the ground, pull them up and keep a record of the number.

3. Mark off another square by the side of the first one, and count the number of seedlings that appear. Watch from time to time and count the number that die.

QUESTIONS

1. Which layer of soil contained the greatest number of seedlings?

2. Why did a number of seedlings die?
3. How many of the young plants could you identify?
4. Go into a forest and note all evidences of a struggle for existence among the trees and plants growing there.
5. Is the struggle greatest between plants of the same kind, or between those of different kinds?

EXERCISE 21

NUMBER OF SEEDS PRODUCED BY PLANTS

TIME: WHENEVER CONVENIENT

Object: To study the productiveness of plants.

Material needed: Paper and pencil.

DIRECTIONS

1. The following data are given in Kerner's *Natural History of Plants*:

a. An average hedge mustard plant (*Sisymbrium sophia*) yields 730,000 seeds.

b. Fleabane (*Erigeron canadense*) yields 120,000 seeds.

c. Shepherd's purse (*Capsella bursa-pastoris*) yields 64,000 seeds.

d. Plantain (*Plantago major*) yields 14,000 seeds.

e. Henbane (*Hyoscyamus niger*) yields 10,000 seeds.

2. Starting with one plant of each of the species mentioned, and supposing each seed to ripen and grow, how many seeds would be produced each year up to and including the fifth? Allowing 40 plants to the square yard, at this rate of production how long would it take each species to cover the State?

EXERCISE 22

VALUE OF BIRDS TO THE FARMER

TIME: WHENEVER CONVENIENT

Object: To learn whether it pays to protect the birds.

Material needed: Paper and pencil.

Facts.—Insects feed on the young and tender foliage of growing plants, but no part of the plant is entirely free from them—some insects attack the seed, others the fruit, stem, or roots. Birds prey largely upon injurious insects. Not only do they destroy great numbers of insects, but they eat great quantities of weed-seeds as well. The State of Illinois loses annually \$20,000,000 by the ravages of insects. This means about 56 cents an acre.

DIRECTIONS

Suppose the damage done by insects in your State is 50 cents an acre, what would be the damage for the entire State?

Suppose there are four birds to the acre, how many would there be in the State?

If each bird eats 20 insects a day (a fair estimate), how many insects would be destroyed during the months of June, July, and August?

Suppose one half of the birds in the State should eat one fourth of an ounce of seed each day for three months. how many pounds of weed-seeds would be destroyed?

EXERCISE 23

ROTATION OF CROPS

TIME: WHENEVER CONVENIENT

Object: To learn the best system of rotation for your section, and compare this system with the one practiced on the farm at home.

Material needed: Paper and pencil.

DIRECTIONS

The system of rotation given below is the one practiced by the North Carolina Agricultural College. Study it carefully and give reasons for each crop's position in the table. Construct a table showing the system of rotation as practiced on your home farm, and let it be discussed before the class. Contrast your system with the one given below. What farmer in your community has the best system?

First Year		Second Year		Third Year		
Summer	Winter	Summer	Winter	Summer	Winter	
<i>Corn</i>	<i>Crimson clover</i>	<i>Cotton</i>	<i>Wheat</i>	<i>Cow peas</i>	<i>Rye for pasture</i>	

QUESTIONS

1. What crops might be substituted in the system above?

2. What crops are nitrogen gatherers?
3. What crops furnish forage for live stock?
4. What crops on account of their tillage bring about weed destruction?
5. What crops would be considered ready-money crops?

EXERCISE 24

FIELD STUDY OF CEREALS

TIME: SUMMER AND FALL

Object: To make a comparison of the five great cereals.

Material needed: Fields, paper and pencil.

DIRECTIONS

Study in the field a number of stalks each of corn, wheat, oats, rye, and barley and tabulate your results as follows:

Name of Plant	Average Height	No. of Blades	No. of Kernels	No. Joints in Stalk	Av. Weight per Bu.	No. Days from Seeding to Maturity
Corn.....						
Wheat.....						
Oats.....						
Rye.....						
Barley.....						

EXERCISE 25

STAND OF CLOVER

TIME: SPRING TERM

Object: To find why some farmers fail to get a good "catch" of clover.

Material needed: Garden rake, clover seed, scythe.

DIRECTIONS

Lay out two small plots on a piece of ground which has been previously seeded to wheat or oats. During the latter part of March seed each plot to clover. When the oats are just heading, cut them from one plot, and leave the other plot unmolested. The second plot may be harvested when the grain is ripe.

Observe late in the fall to see which plot of clover has withstood the dry weather better.

Facts.—The majority of farmers sow clover in fields which have already been seeded to wheat or oats. The result is, if there is a drought during the following summer, a great number of young clover plants die for lack of water. The large amount of water needed to ripen the grain depletes the water in the soil, so that the young plants suffer. It takes about 325 pounds of water to ripen one pound of grain, so in cutting the oats before they ripen, we help the clover plants through the summer.

EXERCISE 26

SEEDING ALFALFA

TIME: FALL OR SPRING TERM

Object: To learn how to seed alfalfa.

Material needed: Plow, harrow, subsoil plow, alfalfa seed, manure, inoculating material.

DIRECTIONS

1. Select a well drained loam soil on the home farm. It should have a good subsoil. Turn, subsoil, and harrow until the soil is thoroughly pulverized. Much depends upon getting a good seed bed.

2. Apply a good coating of stable manure and harrow until it is well incorporated with the soil. You cannot succeed with alfalfa if your soil is acid. Exercise 59 gives instructions for testing the acidity of soils. If you find the soil is acid, you can neutralize it by an application of lime.

3. You may sow the seed either in the fall or in the spring. Fall seeding is better, provided it is done early enough for the young plants to get a good start before freezing weather. Being bothered with troublesome weeds is the greatest objection to seeding in the spring.

4. If seeded in the fall, sow about the first week in October in the South; in September in the northern States. Sow at the rate of 20 pounds an acre.

5. On most soils of the South inoculation is necessary. Find if it is necessary in your section. Write to the United States Department of Agriculture for inoculating material. Instructions are sent with each package.

Another method of inoculating is to secure soil from a field where alfalfa thrives well and broadcast it over the field, either before or after it is seeded. From one to three bushels of soil is sufficient.

EXERCISE 27

HARROWS

TIME: FALL OR SPRING TERM

Object: To find the number of harrows in the community, the kind of harrows, and the purpose for which they are used.

Material needed: Paper and pencil.

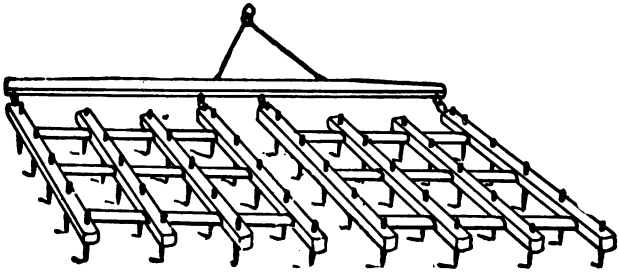


FIG. 4—COMMON HARROW

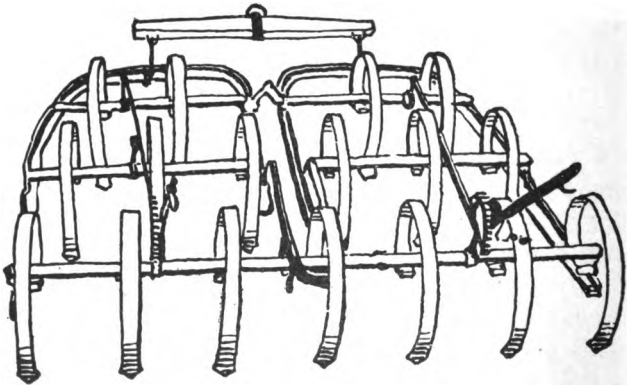


FIG. 5—SPRING-TOOTH HARROW

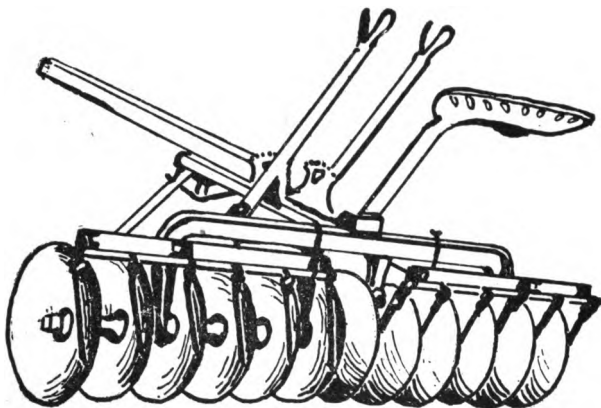


FIG. 6—DISK HARROW

EXPLANATION

There are three classes of harrows:

1. Those that press or fine the soil—common harrows or drags.
2. Those that lift and tear the soil—spring-tooth harrows.
3. Those that slice the soil in action—disk harrows.

DIRECTIONS

Make a list of all the farmers in your community who possess harrows, and name the class to which each harrow belongs.

Let each student write an essay on the use of the harrow.

EXERCISE 28

CUTTING POTATOES FOR PLANTING

TIME: MARCH OR APRIL

Object: To learn whether the number of eyes or the size of the pieces affects the yield of potatoes.

Material needed: Hoe, knife, potatoes.

DIRECTIONS

In the school garden, or at home, lay out six rows of equal length and equal distance apart. Use one row only for each size. The following sizes or methods of cutting may be used:

1. Whole potatoes.
2. Halves.
3. Quarters.
4. Two eyes.
5. One eye.
6. Peelings.

Harvest the potatoes, weigh, note the number of large potatoes and tabulate the results as follows:

Whole Potatoes		Halves		Quarters		Two Eyes		One Eye		Peelings	
No. Bushels	No. Large Potatoes	No. Bushels	No. Large Potatoes	No. Bushels	No. Large Potatoes	No. Bushels	No. Large Potatoes	No. Bushels	No. Large Potatoes	No. Bushels	No. Large Potatoes

EXERCISE 29

HILLING POTATOES

TIME: SPRING AND SUMMER

Object: To determine whether ridge cultivation or level culture should be practiced in growing potatoes.

Material needed: Potatoes, hoe, plow.

DIRECTIONS

Ask the students to plant the potatoes at home. Divide the patch into two parts. Cultivate one part level just as corn is cultivated, but hill up the other half. At digging time note any difference in the yield.

QUESTIONS

1. Which gives the greater yield?
2. How do you account for the difference?
3. Which method requires more labor?
4. Which part loses more moisture? Why?

EXERCISE 30

A COMPARISON OF AGRICULTURAL PRODUCTS OF YOUR STATE WITH THOSE OF OTHER STATES

TIME: FALL OR SPRING TERM

Object: To learn whether the products of farms of this State compare favorably with the products of other States.

Material needed: Paper and pencil.

DIRECTIONS

Take your data from the Year-book of the United States Department of Agriculture (1905) and construct graphic charts, using chart below as a model. Compare the following products:

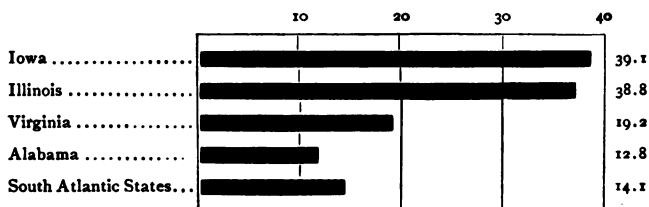
1. Corn: acreage, production, and value of crop.
 2. Cotton: acreage, production, and value of crop.
 3. Wheat: acreage, production, and value of crop.
 4. Oats: acreage, production, and value of crop.
 5. Hay: acreage, production, and value of crop.
-

1. Horses: number, value, and average price per head.
2. Mules: number, value, and average price per head.
3. Milch cows: number, value, and average price per head.

4. Sheep: number, value, and average price per head.

5. Hogs: number, value, and average price per head.

YIELD OF CORN PER ACRE



EXERCISE 31

CROP SUMMARY

TIME: FALL AND SPRING TERMS

Object: To teach students how to keep a complete record of crops and the management of fields.

Material needed: Paper and pencil.

DIRECTIONS

Use the form given below, and let each student keep a complete record of one or more fields on the farm at home. Make an effort to secure the coöperation of the patrons in this work. This should be a means of inducing the farmers to keep, year by year, a record of the production of each field. Impress upon students the importance of being exact in keeping records.

Name County..... District..... P. O.....
CROP.....

Season.... Previous Crop.... Kind of Soil.... No. of Acres....

SOIL PREPARATION

Date of plowing.....	Date of cultivation.....
Implement used....	Implement used.....
Depth plowed.....	Cost of preparing seed bed...
Cost of plowing.....	Condition of land when seeded.....

CROP SEEDING AND CULTIVATION

Date of seeding.....	Cost of fertilizer.....
Rate of seeding.....	Date of germination.....
Cost of seed.....	Dates of cultivation
Kind of fertilizer.....	Implement used.....
Am't of fertilizer an acre....	Cost of cultivation

HARVEST AND YIELD

Date of harvest... ..	Quality of grain.....
Time from seeding to harvest.....	Yield { Grain
Cost of harvest	{ Fodder.....
Total cost of crop.....	Yield an acre { Grain.....
Total cost an acre....	{ Fodder.....
Drilled or not drilled.....	If cotton, pounds an acre....
Rust.....	Stand of crop.....
Smut	Height of crop.....

EXERCISE 32

AN INVENTORY

TIME: WHENEVER CONVENIENT

Object: To learn how to make an inventory of property on the home farm.

Material needed: Paper and pencil.

DIRECTIONS

1. Let each student make a list of the real and personal property, with values, owned by his parents. Use the following as a model:

INVENTORY OF MAPLE GROVE FARM, JANUARY 1, 1907

Assets

300 acres land, with buildings.....	\$6,000
5 head of horses.....	750
12 cows.....	360
15 steers.....	450
20 sheep.....	50
25 hogs.....	150
Poultry	50
Farm machinery.....	600
Oats, 200 bushels.....	80
Wheat, 300 bushels.....	240
Corn, 500 bushels.....	250
Cotton, 10 bales.....	500
Corn stover.....	175
Household furniture.....	275
Hay, 25 tons.....	120
———— \$10,050	

Liabilities

Mortgage on farm.....	\$1,500	
Personal accounts.....	250	
Outstanding notes.....	350	
		<hr/>
		\$2,100
Net capital.....	\$7,950	

2. Have students make another inventory one year hence for comparison.



EXERCISE 33

MEANS OF STUDYING ROOT GROWTH

TIME: DURING GROWING WEATHER

Object: To learn a method by which we may study the growth of roots.

Material needed: Nail keg or barrel, gravel, seeds, knife, box with glass side.

DIRECTIONS

1. In an ordinary nail keg bore four or five holes in the bottom to provide good drainage. Next put in a 3-inch layer of gravel and sink the keg almost to the top in the ground. Fill with rich soil mixed with sand. Plant seeds and leave for five or six weeks under field conditions. Remove the barrel, tear away the staves and wash all the soil from the roots. Observe how the roots are distributed through the soil. Separate all the roots, both large and small, and find the total length of the roots.

2. Construct a box with one side of glass; fill with sand and plant seeds down by the side of the glass. Keep the glass covered so as to have darkness, and keep the sand moist. Examine the growth of the roots daily.

3. Plant seeds at various depths and notice their behavior.

EXERCISE 34

FORMS OF ROOTS

TIME: FALL OR SPRING TERM

Object: To study the different forms of roots.

Material needed: Paper and pencil.



FIG. 7
TAP ROOT OF
ALFALFA

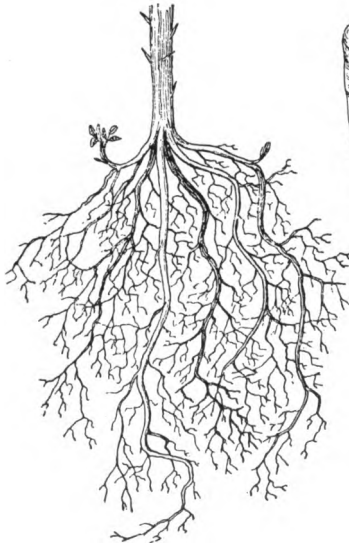


FIG. 8—FIBROUS ROOT OF RASPBERRY

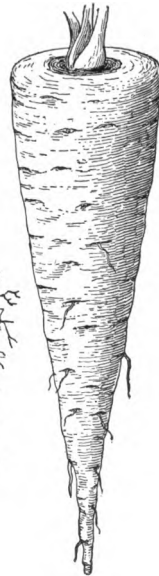


FIG. 9
FLESHY ROOT OF
PARSNIP



FIG. 10—AIR ROOTS OF POISON IVY



FIG. 11—BRACE ROOTS OF CORN

DIRECTIONS

1. You will observe by the cuts in this exercise that plants have various kinds of roots. Study these forms carefully and see if you can think of any advantages in each particular kind.

2. Make a list of plants and group them in the following table, according to their form of root system :

Tap Roots	Fibrous Roots	Brace Roots	Air Roots	Fleshy Roots

QUESTIONS

1. Do air roots take in plant food?
2. What difference do you notice in the appearance of the roots of trees which have long been exposed to the air by the soil having been washed away?
3. Why do some plants send their roots deep into the soil while others keep them near the surface?
4. Does the amount of plant food or moisture affect the depth to which plants send their roots in the soil?

EXERCISE 35

DIRECTION OF GROWTH OF ROOTS

TIME: WHEN WEATHER IS WARM

Object: To learn the direction of root growth and the things which influence this direction.

Material needed: Peas, soil, tumbler, small dish, three clothes-pins, mercury, wooden box (12 x 10 x 3 inches), wire netting, sawdust, blotting paper.

DIRECTIONS

1. Place some peas which have germinated upon moist soil with the radicles (roots) pointing in different directions. Cover with a glass to prevent evap-

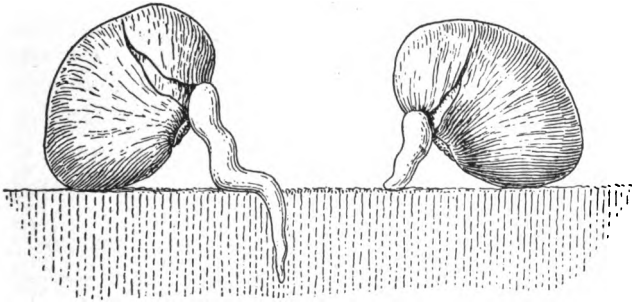


FIG. 12—SPROUTING BEANS

oration and watch closely. Do the root-tips point downward? Do you think the tips of the roots drop downward by their own weight?

2. Fasten three clothes-pins to the side of a small dish, and pour into it some mercury. To each of the clothes-pins pin germinating peas and allow the tips of the roots to rest on the surface of the mercury. Pour on enough water partly to submerge the seeds. What direction do the tips of the roots take? Do they bend by their own weight?

3. Does light, moisture, air, warmth, or food influence the direction of growth? Let us carry the experiment further. In a small box, not over 3 inches deep, having a bottom of wire netting and filled with damp sawdust to one half its depth, place some seeds which have just started to germinate and fill the box with sawdust of equal moisture with that in the bottom of the box. Now cover with blotting paper or cloth and keep moist. Hang up the box so the bottom can be observed.

You will observe: (1) that air, light, and warmth, come mostly from below; (2) moisture is about equally abundant above and below; (3) and the same amount of sawdust is above and under the seed.

Now, why does the root grow downward?

EXERCISE 36

ARTIFICIAL ROOT-HAIR

TIME: FALL OR SPRING TERM

Object: To represent by artificial means the manner in which root-hairs take in plant food.

Material needed: Egg, vinegar, glass tube, sugar, tumbler, thread.

DIRECTIONS

1. Break a small hole in one end of an egg and pour out the contents ; soak the shell in weak acid or vinegar until the shell is dissolved. Insert a small glass tube into the membrane and tie firmly.

2. Now pour into the tube a thick sirup, made of sugar and water, until it rises a short distance above the membrane. Mark the height to which the sirup stands and submerge the membrane in a tumbler of water. What happens to the liquid in the tube?

3. Make a stronger sirup and submerge the membrane in it and note what happens to the fluid in the tube.

Facts.—Root-hairs act in the same way as the membrane. This passage of water into the root-hairs or through the membrane is called osmosis. Strong solutions of salts as found in salt marshes, alkali soils, and peat bogs interfere with the absorption of moisture by the root-hairs, and in some cases the water is even taken from the roots.



FIG. 13

DIAGRAM OF CORN STALK, SHOWING LOSS OF
MOISTURE THROUGH LEAVES

EXERCISE 37

TRANSPIRATION OF WATER BY PLANTS

TIME: WHEN CORN IS TASSELING

Object: To learn that plants absorb water and plant food through the stem, and lose water through the leaves.

Material needed: Three wide-mouthed bottles, corn plants, red ink, white flowers.

DIRECTIONS

1. Fill two wide-mouthed bottles with water and put two freshly cut corn plants of equal size in them. With a sharp knife or pair of scissors cut off one half of the leaves of one stalk; set aside and note the difference in the loss of water from the two bottles.
2. Prepare a third bottle in the same way, but have the water colored with red ink. What happens to the stalk? Try white flowers also and note what occurs.

QUESTIONS

1. Do plants absorb moisture through the leaves?
2. Carry out an experiment which will demonstrate the answer to the first question.
3. Do plants use food in a solid state?
4. Why does the amount of water in streams and in wells sometimes increase in the fall, even when there has not been rain?
5. Do you know of any means by which plants reduce transpiration?

EXERCISE 38

SUNLIGHT AND LEAVES

TIME: WHEN LEAVES ARE GREEN

Object: To determine the effect of sunlight on the green coloring matter of plants.

Material needed: Board, cork, pins, plant in pot.

DIRECTIONS

Place a board on the green grass and let it remain for ten days, then notice if a change has taken

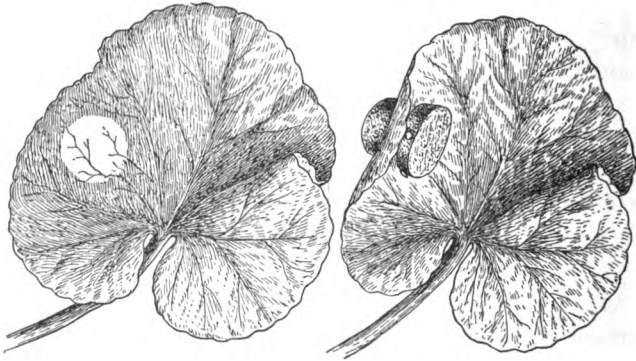


FIG. 14—EFFECT OF LIGHT ON GREEN LEAF

place. How do you account for this change? Examine the same spot again in a few days, the board having been left off. What do you notice at this time?

Fasten two thin, flat pieces of cork to a leaf, as shown in Fig. 14, and examine after a few days. How do you account for what you see then?

Try the same experiment by pinning the cork to a leaf of a pot plant; keep the plant in the dark. Do you get the same result in this case? The green color of leaves is due to chlorophyll.

Facts about Chlorophyll.—Chlorophyll is made up of tiny green grains whose work is to manufacture starch. These green grains can perform their work only while the sun is shining. It is for this reason that potato shoots grown in a dark cellar are always white. Chlorophyll, in the presence of sunlight, acts upon the absorbed carbon dioxide, thus producing a chemical change; the carbon dioxide is broken up, the carbon is united with water, forming starch, while the oxygen in the carbon dioxide is given back to the air.

EXERCISE 39

DECOMPOSITION OF CARBON DIOXIDE BY LEAVES

TIME: DURING GROWING WEATHER

Object: To determine whether leaves decompose carbon dioxide.

Material needed: Cork, candle, shallow vessel, fruit-jars.

DIRECTIONS

Fasten a lighted candle to a flat piece of cork so it will float; set it in a shallow vessel of water and invert a fruit-jar over it. If after a while the candle goes out, it indicates that some of the oxygen in the air above the water has been converted into water and carbon dioxide.

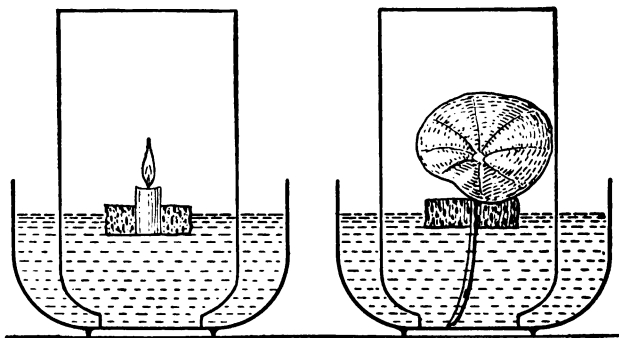


FIG. 15—EXPERIMENT WITH OXYGEN AND CARBON DIOXIDE IN
THE AIR

Withdraw the candle and cork by means of a string which must be attached to the cork before the jar is inverted over it. Make a hole through another piece of cork and slip the stalk of a green leaf through it. Lift the bottom of the inverted jar nearly to the surface of the water and introduce the leaf under the jar, using care so as not to admit any air. Remove the vessel containing the jar and water to a place in the sunshine. Leave in the sun for two days, and remove the leaf. Carefully lift the jar slightly above the surface of the water and introduce the lighted candle as before. If the candle does not immediately go out, it is a proof that some of the carbon dioxide has been decomposed, thus liberating some of the oxygen which supports combustion.

EXERCISE 40

ANNUAL RINGS OF TREES

TIME: SPRING TERM

Object: To study the formation of rings in trees.

Material needed: Knife, piece of tin, wax.

DIRECTIONS

1. Examine the end of a log which has been smoothly cut in two. Count from the center outward in three directions. Do you find the same number of rings in each count? Can you trace each ring all the way around the log? Find a knot on a small log or a large limb; saw the log in two at the knot. Can you trace the rings all the way around? Where does the knot originate? Are knots ever beneficial in lumber? Suppose the growth of trees is almost checked by a drouth during the summer and later the coming of rains causes them to begin growth again, would there be two rings formed that season? What would be the effect upon the rings if the leaves are destroyed by insects and new leaves are put forth during the summer? Can we always tell the age of trees by the annual rings?

2. Select a stem 1 inch in diameter and cut through the bark three quarters the way around; pull each end of the severed bark from the wood for the distance of 1 inch. Carefully lift the unsevered bark

from the wood and under it place a thin piece of tin, 2 inches wide, and long enough to reach completely around the

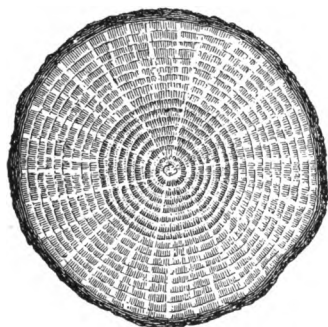


FIG. 16

CROSS-SECTION OF HARDWOOD LOG

stem. When the tin is in place, put the bark down over it, tie firmly and cover with grafting wax so as to exclude the air. After 40 days the twine may be removed. In December cut away the bark covering the tin. Do you find any wood between the tin and the bark?

3. Make a list of plants which form annual rings. Is there any relation between those plants forming annual rings and either class of plants in Exercise 19?

EXERCISE 41

GROWTH OF STEMS

TIME: LATE IN THE SPRING

Object: To learn the manner in which stems grow.

Material needed: Apple branch, pots for growing twining plants.

DIRECTIONS

1. Take from an apple tree a limb having several branches, and find the rings which show the annual growths. These rings are clusters of bud scale scars formed by the terminal bud. What is the object of the terminal bud? Suppose you plant a tree having its fork 3 feet from the ground, how high will the fork be in 10 years? Which way do stems grow—by a stretching process or by the addition of material at the end?



FIG. 17
BUDS
OF
PEACH

2. Make a study of twining stems and observe that some turn clockwise, while others turn counter-clockwise. Grow a number of twining plants in pots; use sticks for support. Turn one pot over on its side so the plant will be in a horizontal position. Does this affect the twining? Use supports of different sizes and note the effect. Place a glass rod in one pot for a support, and observe whether a plant can twine as well on a smooth support as on a rough one. Place one plant in the dark and observe whether light affects the twining.

3. Make a drawing of an oak which you have seen growing in a forest; the same of one which has been growing in an open field for a long time. If you note a difference in form, how do you account for it? Is there such a thing as natural pruning? Would you top a timber tree?

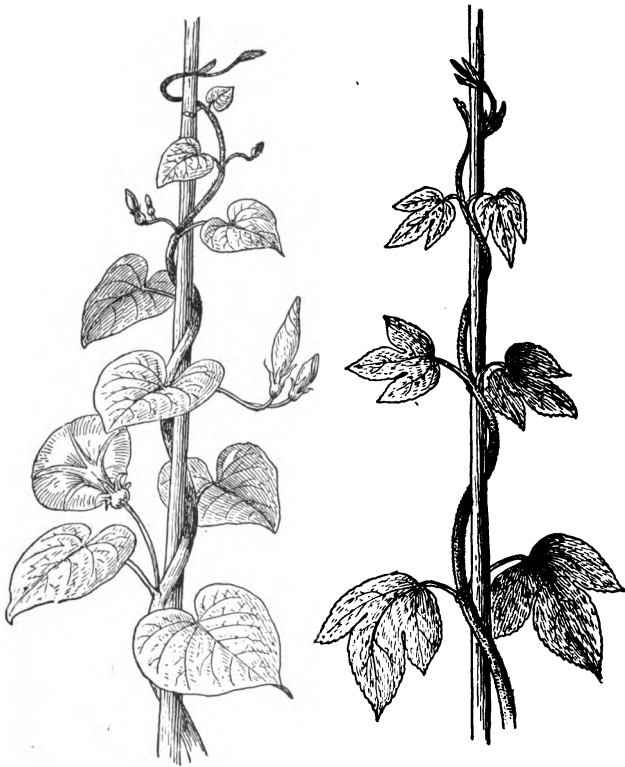


FIG. 18—TWINING STEMS: MORNING-GLORY (LEFT); HOP (RIGHT)

4. Select a young brier shoot or some rapidly growing plant; make a mark a few inches from the tip early in the morning, measure late in the afternoon, and note the growth during the day; find the growth during the night. Is the growth more rapid during the daytime or the night?

EXERCISE 42

FORMS OF TREES

TIME: FALL OR SPRING TERM

Object: To study the two forms of trees.

Material needed: Paper and pencil.

DIRECTIONS

1. Study the forms of trees in Fig. 19. Trees whose main stems are carried on in a direct line through their whole growth are called excurrent. This form is due to the development year after year

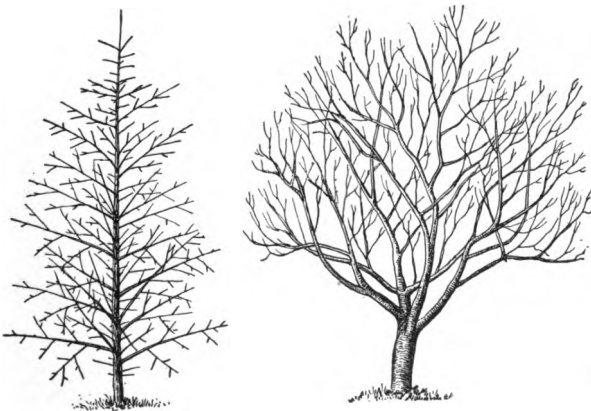


FIG. 19—FORMS OF TREES. DIAGRAM OF SPRUCE (EXCURRENT) AT LEFT; AND PEACH (DELIQUESCENT) AT RIGHT

of a terminal bud. The main shaft is never confounded with the branches which proceed from it. Pines and firs are good examples of this form.

Those trees in which the terminal bud fails to take the lead regularly and whose trunks are lost in their branches are called deliquescent. The American elm is a good example of this type.

2. Make a list of each type of trees.

QUESTIONS

1. Which type is cut for lumber?
2. To which form do most of our fruit trees belong?
3. Which type is best for shade trees?

EXERCISE 43

PARTS OF A FLOWER

TIME: WHEN FLOWERS CAN BE OBTAINED

Object: To learn all the parts of a flower.

Material needed: Flowers.

DIRECTIONS

Take for study a plum, peach, or apple blossom. Remove the calyx or whorl of green leaves at the base of the flower. How many of these leaves did you remove? Each of these leaves is called a sepal.

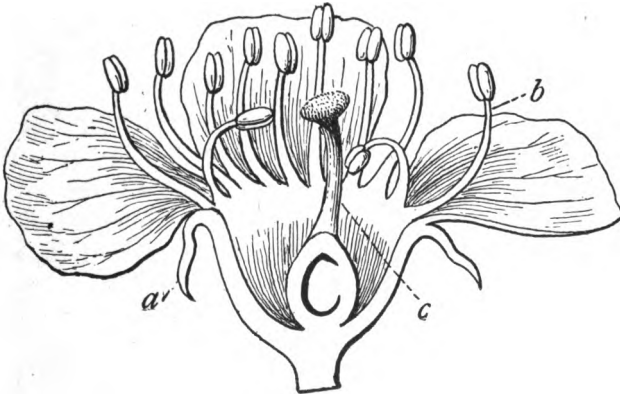


FIG. 20—CROSS-SECTION OF CHERRY FLOWER: *a*, SEPAL; *b*, STAMEN; *c*, PISTIL

There is a whorl of colored leaves just above the calyx; call this the corolla, and each separate leaf a petal.

Look just inside the petals for a number of thread-like parts with a knob at the top; these are the stamens. Now examine one stamen closely (Fig. 21). The knob at the end is the anther, which bears the pollen. Open one of the anthers and observe the small yellow grains of pollen. The stalk of the stamen is the filament.

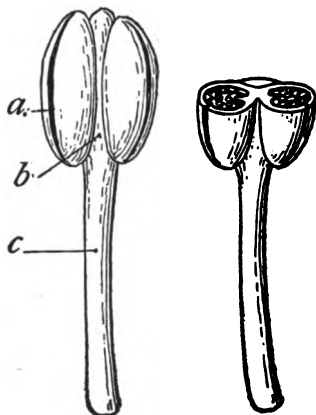


FIG. 21—TYPICAL STAMENS:
a, ANTHER; *b*, SHOWING MODE
OF ATTACHMENT; *c*, FILAMENT

In the center of the flower is a stalk with an enlarged base. This is the pistil. Let us study the pistil separately (Fig. 22). You will observe it is made up of three parts: the enlargement at the top is the stigma, which receives the pollen from the anthers; the middle portion is the style; and the base is the ovary.

Study a number of flowers of different kinds with reference to the number of parts they contain, and tabulate your results as follows:

Name of Flower	No. Sepals	No. Petals	No. Stamens	No. Pistils

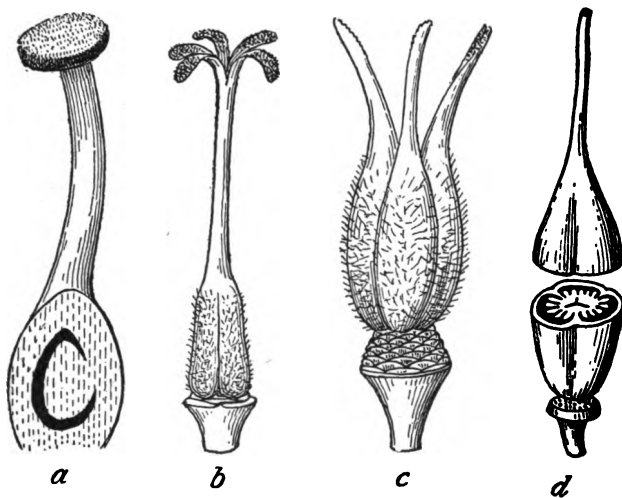


FIG. 22—VARIOUS FORMS OF PISTILS: *a*, CHERRY; *b*, WILD GERANIUM; *c*, ST. JOHN'S-WORT (COMPOUND PISTIL); *d*, ST. JOHN'S-WORT

EXERCISE 44

USES OF THE PARTS OF A FLOWER

TIME: WHEN FLOWERS ARE BLOOMING

Object: To learn the uses of the parts of a flower.

Material needed: Flowers in yard or field.

DIRECTIONS

1. To find the use of the calyx: For this experiment select large flowers, such as poppy, rose, etc. Begin when the buds are small and remove the calyx, taking care not to injure other parts of the flower. Treat about half a dozen buds and label them. Label some untreated buds to serve as a control.

How do the treated flowers develop?

Since the calyx is green, does it perform the function of a true leaf?

2. To find the use of the corolla: Cut away the corollas of flowers frequented by insects, and observe whether the insects cease their visits. Notice that small flowers are usually grouped in clusters; does this help to attract insects? Find some flowers with bright, showy colors, and watch for visits by insects. Are they frequent?

3. To find the use of stamens and pistils: Stamens of the corn plant are borne on the tassels, and the pistils are the silks. Find an isolated stalk

somewhere and remove the tassel just as it appears; examine when the silk is dead. Are there any kernels? Suppose you find a few scattered kernels on the cob, what does this prove? Tie a paper bag over an ear before the silk appears, so as to exclude all pollen, and examine later. What effects do you notice on the silks and the kernels?

EXERCISE 45

FURTHER STUDY OF FLOWERS IN THEIR RELATION TO INSECTS

TIME: WHEN FLOWERS ARE BLOOMING

Object: To discover the part insects play in plant life.
Material needed: Flowers in the field.

DIRECTIONS

1. Study the flower of the wheat plant. Has it the same kinds of parts as other flowers? Are these flowers visited by insects? Who can find just the hour in which the wheat flower opens?

2. Describe the flowers of pines, oaks, and nettles. Why do they produce an abundance of pollen? Does corn produce more or less pollen relatively than wheat, and why?

3. Are the flowers of grape and Virginia creeper visited by insects? Are the flowers conspicuous? Do they have an attractive odor? Draw some conclusions from these observations.

4. Collect several kinds of flowers and endeavor to find the nectar, or honey. In what part of the flower do you find the nectar? Do all flowers have nectar? Does the nectar benefit the flower?

QUESTIONS

1. Why are the flowers blooming late in the fall usually dull in color?
2. Why does the honey-bee visit white clover, and the bumble bee red clover?
3. Would it be well to use the first cutting of clover for seed?

EXERCISE 46

PERFECT AND IMPERFECT STRAWBERRY BLOSSOMS

TIME: WHEN STRAWBERRIES ARE IN BLOOM

Object: To learn how to distinguish between perfect and imperfect blossoms, and what variety will produce fruit without the aid of another variety.

Material needed: Strawberry blossoms, seed catalogue.

DIRECTIONS

Collect some strawberry blossoms for study. Try to find both perfect and imperfect flowers. The perfect flowers bear both pistils and stamens; the pistils are grouped in the center of the flower, while the stamens are located around these at the base of the petals. The pistils are pointed, but the stamens have a knob on top. The imperfect flowers bear pistils only, and cannot produce fruit unless they are planted near a variety which has perfect flowers.

It would be safe to set out a variety bearing imperfect flowers, provided you set the third or fourth row each time with some variety bearing perfect flowers.

Suppose you wish to know what varieties are perfect or imperfect, when getting ready to order plants. Look in the catalogue where the varieties

are described, and you will see the letters "P" and "S." "P" means the variety has imperfect flowers;



FIG. 23—STRAWBERRY BLOSSOMS: *a*, PERFECT OR STAMINATE;
b, IMPERFECT OR PISTILLATE

pistils but no stamens. "S" means staminate; the variety bears perfect flowers.

EXERCISE 47

ROSE CUTTINGS

TIME: FALL TERM, JUST BEFORE FROST

Object: To learn how to make rose cuttings, and have rose bushes for the home or school grounds.

Material needed: Knife, rose cuttings, spade, window pane.

DIRECTIONS

1. Take a number of cuttings from rose bushes, using stems of one year's growth. Cut the stems into pieces of about 6 inches long, and remove at least half the leaves on each cutting. Make a slanting cut, $\frac{1}{2}$ inch long, at the base of each, so there will be more surface for the roots to form.



FIG. 24
ROSE CUTTING TAKING ROOT

2. The size of the excavation for these cuttings will depend upon the number to be started, and the size of the glass with which it must be covered. Suppose the glass is 12x16 inches, then dig the hole just large enough to be barely covered by the glass. Let the hole be 18 inches deep. Put into the hole a layer of soil, 6

inches deep; over this put a layer of 5 inches of sand.

3. Set the cuttings 3 inches deep in the sand, and press the sand firmly about them. Put the glass in place, press down firmly and cover the edges of the glass with soil so as to exclude the air. Make a small trench around it to turn the water away.

4. Why do florists keep bulbs, after potting them, the cuttings and pot them, or set them in the soil.



EXERCISE 48

LIGHT AND GERMINATION

TIME: SPRING TERM

Object: To determine whether light affects germination.

Material needed: Germination boxes or plates of sand, corn.

DIRECTIONS

1. Take two germination boxes, two flower pots, or two plates of sand. In each plant 100 kernels of corn; place tips downward.

2. Place one box in the dark; one in the light. Let the temperature be as nearly alike as possible. Examine daily and record your results as follows:

	No. up 4th Day	No. up 5th Day	No. up 6th Day	No. up 7th Day	No. up 8th Day	No. up 9th Day	No. up 10th Day
In light.....							
In dark.....							

QUESTIONS

1. Does light affect germination?
2. Name all the conditions for germination.
3. We have dormant buds. Are there dormant seeds?
4. Why do florists keep bulbs, after potting them, in the dark for several weeks before bringing them into the light?

EXERCISE 49

DIFFERENT TYPES OF SOILS AFFECT GERMINATION

TIME: DURING GROWING WEATHER

Object: To determine the effect of soils upon germination, and to observe the effect of working soils when too wet.

Material needed: Three plates, clay soil, humus, sand, seeds.

DIRECTIONS

1. Fill a plate with some clay soil; apply water, and puddle. Attempt to do this with a plate containing humus and another containing sand. What differences do you see?
2. Plant the same number of seeds in each plate and notice the results.
3. Add sand to the clay and attempt to puddle; plant seeds and note the results. These experiments illustrate why soils should not be worked when too wet.

EXERCISE 50

AGE AFFECTS GERMINATION

TIME: WHENEVER CONVENIENT

Object: To determine whether old seed should be planted.

Material needed: Germination boxes, old seeds.

DIRECTIONS

Let the pupils bring some very old seeds of different kinds from their homes. Make germination tests and compare with a germination test of new seed. Study table given below:

NUMBER OF YEARS THAT SEEDS RETAIN THEIR POWER TO GERMINATE

1 Year	2 Years	3 Years	4 Years	5 Years	6 Years	10 Years
Chervil Sea Kale	Soy Bean Hop Corn Onion	Leek Parsley Pea Rhubarb Strawberry	Carrot Lentils Mustard Tomato	Muskmelon Kale Asparagus Cabbage Lettuce Turnip Spinach	Bean Eggplant Watermelon Pumpkin Squash	Cucumber Wheat Oats Flax Buckwheat Barley

EXERCISE 51

GERMINATION TEST OF SEEDS

TIME: FALL OR SPRING TERM

Object: To find the percentage of germination of various seeds, and make a comparison with the germination "standards."

Material needed: Germination boxes, variety of seeds.

DIRECTIONS

1. Make a germination test of different seeds, and place the percentage of germination in the blank column in the table below, so that a comparison can be made with the standards, which are also given in the same table.

2. For small seeds take sample with spoon here and there through the mass and mix thoroughly. In testing large seeds, use 100; small seeds, 200 to 300.

3. Allow from 10 to 20 days for the germination of grass seed; and from 2 to 7 for cereals, clovers, peas, and vetches. The best temperature is from 65° to 75°.

GERMINATION TABLE

Name of Seeds	Standard	% Germ.	Name of Seed	Standard	% Germ.
Beans.....	95		Oats.....	95	
Corn.....	93		Peas.....	98	
Alsike clover.....	85		Sorghum.....	90	
Orchard grass.....	80		Turnip.....	95	
Sunflower.....	90		White clover.....	85	
Tobacco.....	88		Ky. blue grass.....	50	
Buckwheat.....	92		Pumpkin.....	92	
Red clover.....	90		Timothy.....	90	
Millet.....	85		Wheat.....	95	

Allowing for seed that will not germinate, how much to the acre of the tested seed should be used? Let the instructor give the usual rate of seeding an acre of the various seeds.

EXERCISE 52

DEPTH AFFECTS GERMINATION

TIME: WHENEVER CONVENIENT

Object: To show the effect of depth of planting upon germination and stand of crop.

Material needed: Box and seeds.

DIRECTIONS

1. Fill a box 8 inches deep, and 12 or more inches square, with good soil. Mark off rows in which to plant the seed. In the first row plant 12 seeds, 1 inch deep; in the second row, 12 seeds, 2 inches deep; in the third row, 12 seeds, 4 inches deep; in the fourth row, 12 seeds, 6 inches deep.

2. Use large, medium, and small seeds and keep results in table below.

Kind of Seeds	Depth of Planting	No. up 4th Day	No. up 5th Day	No. up 6th Day	No. up 7th Day	No. up 8th Day	No. up 9th Day	No. up 10th Day	No. up 11th Day
Corn.....									
Wheat.....									
Mustard.....									

QUESTIONS

1. How does depth of planting affect germination?
2. Is there any relation between the depth of planting and the size of seeds?
3. Can the farmer always regulate the depth of planting?
4. How deep should corn be planted? Name some conditions which might cause us to vary the depth of planting.

EXERCISE 53

CARBON DIOXIDE FORMED BY GERMINATING SEEDS

TIME: WHENEVER CONVENIENT

Object: To determine whether the germinating seeds give back anything into the atmosphere.

Material needed: Glass jar, corn, lime water, two tumblers, glass tube.

DIRECTIONS

Fill a fruit jar one-third full of sprouting corn and place in it a small glass filled with lime water. Place another glass of lime water in a second jar and set beside the first. Cover both jars tightly. Leave for several hours and observe the difference in the appearance of the liquid in the two glasses.

Breathe into another glass of fresh lime water and note any change in its appearance. It would be well to use a quill for this purpose.

Lime water may be prepared by stirring a small amount of fresh lime in clear water. Let stand until all the undissolved lime has settled to the bottom of the vessel, then pour off the clear liquid.

Facts.—In the two cases above, the carbon dioxide from the germinating seed and from the lungs unites with the calcium in the water, thus forming calcium carbonate, which gives the water its milky appearance. Ordinary limestone is calcium carbonate, and

when we burn it in making lime, we simply drive off the carbon dioxide into the air. Animals in breathing give off carbon dioxide, while plants take it in through their leaves and use the carbon in the formation of starch. Carbon dioxide is often called carbonic acid gas.

EXERCISE 54

THE RELATIVE VALUE OF LARGE AND SMALL SEED

TIME: DURING GROWING WEATHER

Object: To find whether large or small seed should be planted.

Material needed: Germination boxes, large and small seeds.

DIRECTIONS

Fill two flower pots or two boxes with rich soil. Plant 25 large seeds in one, and 25 small seeds in the other. Note any variation in the per cent. of germination. Examine from time to time, and record any differences you may observe. Be sure to have the two lots under like conditions. When watering, always apply the same amount of water to each lot. At the end of three weeks make a record of the height of plants, size of stems, number of leaves, etc.

QUESTIONS

1. Does it make any difference in the health and vigor of a plant whether it is grown from a large and well developed seed or from a weak and puny one?

2. Would you consider a farmer wise who markets all his best grain and keeps only the inferior for seed?

3. What would be the ultimate result of repeated plantings made from the worst seed? Of repeated plantings of the best and most vigorous?

EXERCISE 55

THE EFFECT OF FREEZING UPON THE GERMINATION OF SEEDS

TIME: DURING FREEZING WEATHER

Object: To determine whether moist or dry seeds are injured most by freezing.

Material needed: Germination box, seeds.

DIRECTIONS

1. Soak two dozen seeds in water for two hours; remove from water, and when the surface of the seeds is dry, place one dozen out of doors for 24 hours, so that they may freeze.* Keep the other dozen indoors.

2. Soak another two dozen seeds for six hours, and treat as above. Germinate the four lots of seed separately and note the percentage of germination.

Treatment	Per cent. of Germination
1. Soaked two hours, exposed.....
2. Soaked two hours, unexposed.....
3. Soaked six hours, exposed.....
4. Soaked six hours, unexposed.

* This experiment could be performed during warm weather by placing seeds in a water-tight vessel, then packing chips of ice around the vessel.

EXERCISE 56

FOOD FOR YOUNG PLANTS

TIME: FALL OR SPRING TERM

Object: To ascertain whether the germinating seed acquires new material from its surroundings from the beginning.

Material needed: Germination boxes, seeds, scales.

DIRECTIONS

1. Take about half a pound of dry corn, beans or peas; divide into four lots and weigh each lot separately. Arrange the lots for germination, using care to have them under the same conditions.

2. After 48 hours remove all the seeds from the first lot; dry, weigh and compare weight with the original weight.

3. When the end of the germ first makes its appearance in the second lot, remove, dry thoroughly and weigh. Compare weight with original weight.

4. Later, as the seeds sprout in the third lot, dry, and weigh as before.

5. Wait until the first leaves appear in the fourth lot, dry and weigh.

QUESTIONS

1. At what stage is the weight permanently increased?

2. From what source does the plant obtain its first food?

3. What is the per cent. of increase in weight in each stage?

4. When does the plant first begin to take food from the soil? From the air?

EXERCISE 57

TYPES OF SOIL

TIME: FALL OR SPRING TERM

Object: To learn the different types of soils.

Material needed: Field work.

DIRECTIONS

Study the definitions of the types given below and go into the fields and collect small samples of each type.

1. Sandy soils contain large amounts of sand.
2. Clay soils include all those containing large amounts of clay, and may be known by their sticky character. A mixture of sand and clay forms loam.
3. Sandy loams contain considerably more sand than clay.
4. Clay loams contain considerably more clay than sand.
5. Humus soils contain large amounts of decaying organic matter.

QUESTIONS

1. Which type of soil is the commonest in your locality?
2. Name some crops specially adapted to each class.
3. What type should you prefer to cultivate? Why?

EXERCISE 58

SAND, SILT, AND CLAY

TIME: FALL OR SPRING TERM

Object: To separate the sand, silt, and clay in soils.

Material needed: Three fruit jars, clay soil.

DIRECTIONS

Fill a fruit jar three-fourths full of water and place in the water about two tablespoonfuls of pulverized soil. Replace the cover and shake vigorously for several minutes. Let stand for a minute, and pour the muddy water into a second jar. The sediment remaining in the first jar is composed almost entirely of sand. Examine it carefully. Does it look more like sand than the original soil?

When the second jar has been standing five minutes, pour off the muddy water again into a third jar. Add more water to the sediment in the second jar, shake vigorously and let stand five minutes, then pour off the water as before. The sediment now remaining is largely silt, whose particles are finer than sand.

Let the water in the third jar stand two hours or longer, then pour off the water. Now you have clay remaining. Note how fine the particles are.

Facts.—It takes 23,000 grains of fine clay or 23

grains of fine gravel to span 1 inch. There are about 327,000 grains of coarse sand in a pound of earth, and 100 times as many grains of very fine sand. Soils that have the largest number of small soil grains generally possess the largest pore space.

EXERCISE 59

ACIDITY OF SOILS

TIME: SPRING TERM

Object: To show whether soils are acid, alkaline, or neutral.

Material needed: Litmus paper, vinegar, soil.

DIRECTIONS

1. Dip a piece of blue litmus paper in vinegar and note the change of color. ' Moisten a piece of red litmus paper and press against some ashes and observe the color change. Dip both red and blue litmus paper in fresh water, and what is the result?.

Substances that turn blue litmus paper red are acid.

Substances that turn red litmus paper blue are alkaline.

Substances that do not change the color of either are neutral.

2. Moisten some ordinary soil and test with litmus paper. If the color does not change, it is neutral.

Facts.—Soils should be neutral or slightly alkaline. Turning under large crops of green material has a tendency to make soils acid. Acid soils may be neutralized by the application of lime.

EXERCISE 60

EFFECT OF ROLLING AND EXCESSIVE EVAPORATION ON SOIL TEMPERATURE

TIME: SPRING TERM

Object: To determine the effect of rolling and rapid evaporation on the temperature of the soil.

Material needed: *Bucket, roller, thermometer.*

DIRECTIONS

1. For this exercise select three small plots in a cultivated field, free from vegetation. Leave the first plot untreated; apply water to the second until it is thoroughly saturated; roll the third plot.
2. Record the temperature for four days and tabulate the data as in Exercise 61.

QUESTIONS

1. Which of the three plots has the highest temperature for the different depths?
2. Did rolling affect the temperature of the soil?
3. Does rolling in any way affect the evaporation from the rolled surface?
4. How many farmers in your community use a roller? For what purpose do they use it?

EXERCISE 61

CULTIVATION AFFECTS THE TEMPERATURE OF THE SOIL

TIME: APRIL OR MAY

Object: To show that deep cultivation, under most conditions, renders the soil cooler, and shallow cultivation warmer, than the uncultivated soil.

Material needed: Thermometer, hoe or rake.

DIRECTIONS

1. Prepare three adjoining plots of ground; leave the first uncultivated; cultivate the second to a depth of $1\frac{1}{2}$ inches, and the third to a depth of 4 inches.

2. Take the temperature of each plot $1\frac{1}{2}$, 3, and 6 inches below the surface; take air temperature at the same time; repeat the readings for three days and tabulate the data as follows:

Date	Hour	Temp. of Air	Plot No. 1			Plot No. 2			Plot No. 3		
			1.5 in.	3 in.	6 in.	1.5 in.	3 in.	6 in.	1.5 in.	3 in.	6 in.

EXERCISE 62

INFLUENCE OF COLOR ON SOIL TEMPERATURE

TIME: APRIL OR MAY

Object: To learn whether the color of soils affects soil temperature.

Material needed: Hoe, soot or powdered charcoal, lime, thermometer.

DIRECTIONS

Select three cultivated plots, free from vegetation; leave the first untreated; apply soot, charcoal, or some black material to the second until the surface is thoroughly blackened; cover the third plot with a dressing of lime. The plots need not be over 3 or 4 feet square. Take hourly readings for 10 hours, both on a clear and on a cloudy day, and tabulate the data as in Exercise 61.

QUESTIONS

1. How do the plots vary in temperature on a clear day? On a cloudy day?
2. To what is the color of the soils due?
3. Will organic matter in the soil affect its temperature?

EXERCISE 63

KINDS OF MOISTURE IN THE SOIL

TIME: FALL OR SPRING TERM

Object: To learn the three kinds of moisture in the soil.

Material needed: Flower pot, soil, pan, scales.

DIRECTIONS

1. Nearly fill a flower pot with soil and apply water slowly until it trickles through the pot. Set the pot in a pan so as to catch the water that passes through it.

This water passes through by the force of gravity and is called gravitational or free water.

2. When the water ceases to drip from the pot, transfer the soil to a wide, previously weighed pan; weigh and spread out thinly. Leave for several days where it will not be molested. When you think the soil is "air-dry" weigh again; the loss in weight represents the weight of the second kind of moisture. This is called capillary moisture.

Capillary moisture is held in the capillary spaces or pores of the soil and is not influenced by gravity, but may move in any direction, usually upward, or toward the drier soil.

3. The "air-dry" soil above contains the third kind of moisture. This we call hygroscopic moisture. It consists of a very thin film of moisture sur-

rounding each soil grain. It is not free to move about like capillary moisture, and can be removed only by heating the soil to the boiling point of water (212° F.), when it passes off as steam.

QUESTIONS

1. What becomes of the water which falls upon the ground?
2. Can the farmer control the three kinds of moisture?
3. Which kind would be affected by deep plowing?

EXERCISE 64

SOIL WATER HOLDS PLANT FOOD

TIME: WHENEVER CONVENIENT

Object: To show that well water holds plant food in solution, and rain water does not.

Material needed: Rain water, well water, cotton, two tumblers, seeds.

DIRECTIONS

1. Boil one half gallon each of rain water and well water until the volume is reduced one half. The rain water is boiled to drive off the gases absorbed from the air, and the well water to make stronger the mineral matter which it contains.

2. Pour a part of the rain water in a glass or a small, wide-mouthed bottle. Place upon the water a thin layer of cotton, and upon the cotton place six seeds which have already been germinated. Do likewise with the well water. Place in the light in a warm room.

QUESTIONS

1. Which shows the most vigorous growth?
2. Why is there no plant food in the rain water?
3. In what form do plants use their food?
4. Why should the water in the bottles be changed every few days?

EXERCISE 65

THE EFFECT OF A MULCH IN PREVENTING THE LOSS OF MOISTURE BY EVAPORATION

TIME: DURING GROWING WEATHER

Object: To determine whether a mulch prevents the loss of moisture from the soil by checking evaporation.

Material needed: Two boxes, seeds, potatoes, straw or leaves, hoe.

DIRECTIONS

1. Fill two flower pots, or two boxes of equal size, with rich soil and plant seeds in earth. Saturate each pot with water and cover the soil in one pot with a layer of fine leaves, or other organic matter. When the young plants come up, thin out to an equal number. Keep the two pots under like conditions of temperature, but do not water either pot. Which pot keeps the plants in a growing condition longer?

2. Repeat this experiment under field conditions. Plant two small plots of equal fertility in potatoes; cover one with a mulch of wheat straw and cultivate the other one in the usual way. Which produces the better yield? In case there is a wet season, would you expect much difference in the yield of the two plots?

EXERCISE 66

AIR IN SOILS

TIME: MAY OR JUNE

Object: To observe how plants suffer for want of air.
Material needed: Two flower pots, seeds.

DIRECTIONS

Fill two flower pots with rich soil and plant seeds in each; when the plants are 3 inches high, keep the soil in one soaked with water all the time and apply water to the other pot only as it is needed. In a few days observe carefully the difference in the appearance of the two plants.

QUESTIONS

1. Which plant grows the faster?
2. What difference do you observe in the color of the two plants?
3. Do you think there is any difference in the temperature of the two pots?
4. How does water affect the amount of air in the soil?
5. Why are undrained fields unprofitable?

EXERCISE 67

WATER CAPACITY OF SOILS

TIME: WHENEVER CONVENIENT

Object: To determine the water capacity of soils.

Material needed: Three lamp chimneys, cheese cloth, scales.

DIRECTIONS

Tie a piece of cheese cloth over the large end of each of three lamp chimneys, and weigh each separately. Place samples of clay, loam, and sand near the stove for 24 hours or until they are dry. Fill one chimney with clay, one with loam, and one with sand; hold over a vessel and saturate the contents of the chimneys with water. Let stand until the water ceases to drip, then weigh and tabulate the data as follows:

Kind of Soil	Weight of Chimney	Weight of Soil	Weight of Water Absorbed	Per cent. of Water Absorbed
Clay.....				
Loam.....				
Sand				

EXERCISE 68

THE EFFECT OF ORGANIC MATTER AND SAND ON BAKING OF CLAY SOILS

TIME: FALL OR SPRING TERM

Object: To show the degree to which organic matter and sand prevent the baking of clay soils.

Material needed: Five flower pots or boxes, sand, clay, humus.

DIRECTIONS

1. Secure five one-gallon flower pots or jars, provided with drainage outlets; fill them to within 1 inch of the top as follows:

No. 1—Clay.

No. 2—Clay thoroughly mixed with 20 per cent. of humus.

No. 3—Clay thoroughly mixed with 30 per cent. of sand.

No. 4—Clay thoroughly mixed with 20 per cent. of sand.

No. 5—Clay thoroughly mixed with 30 per cent. of humus.

2. Use the same amount of water in each case and thoroughly saturate the soil. Place the pots in the direct rays of the sun until the soil is baked. Note the ease with which the different soils can be pulverized by the fingers.

QUESTIONS

1. How do sand and humus affect the soil?
2. What plants would have the greatest difficulty in coming up in a baked clay soil?
3. Can the farmer do anything to prevent the baking of the soil?

EXERCISE 69

FIXATION OF PLANT FOOD BY SOILS

TIME: FALL OR SPRING TERM

Object: To learn whether soils have the power to "fix" plant food.

Material needed: Lamp chimney, cheese cloth, ammonia water, potash, litmus paper.

DIRECTIONS

Tie a piece of cheese cloth over one end of a lamp chimney; fill the chimney with clay soil or garden loam, and pack firmly. Set the chimney in a vessel and pour in the top some ammonia water. Do you detect any odor of ammonia in the water which has passed through the soil? Repeat the experiment with coarse sand, and note what results.

Repeat the experiment by pouring over the soil liquid manure and water containing potash in solution. What effect has the soil on the liquid? Test the potash solution with litmus paper. How is it affected?

Facts.—Clay, which contains alumina and silica combined, lime, magnesia, and iron are good fixing agents. These fixing agents prevent the loss of plant food by leaching. Many farmers make the mistake of applying immediately available ingredients of plant food, as nitrate of soda, before the crop is

ready to use it. Rock phosphate and bone meal are ingredients which may be applied a considerable time before plants are ready for their use. We should not fail to state that the "fixing" agents mentioned above are inorganic substances, and that humus is of equal importance as a "fixing" agent.

The amount of plant food in the soil depends largely upon three things: (1) The kind of rock from which the soil is formed; (2) the kind and quantity of plants grown thereon; (3) and the "fixing" power of the soil.

EXERCISE 70

COLLECTION OF TYPES OF SOILS

TIME: SPRING TERM

Object: To make a collection of all the types of soil in the community; classify them; study their characteristic growth; and find average price an acre.

Material needed: Various types of soil.

DIRECTIONS

Have each student bring from the home farm as many types of soil as he can find, such as clay, sand, loam, clay loam, sandy loam, gravelly soil and leaf mold. Classify and tabulate your results as follows:

Collector	Kind of Soil	Where Found	Characteristic Growth	Price of Soil per Acre

QUESTIONS

1. Why are some soils more valuable than others?
2. Do certain crops grow better on some soils than on others? Why?

EXERCISE 71

SOIL WASHING AND ITS PREVENTION

TIME: FALL OR SPRING TERM

Object: To study the causes of soil washing and means for its prevention.

Material needed: Paper and pencil.

DIRECTIONS

1. Outline conditions which determine the extent of soil washing.
2. Outline means by which the washing of soils may be prevented.
3. Make a list of farmers in the community who have badly washed fields. Were these fields washed during the possession of the present owners?

EXERCISE 72

CHEMICAL ELEMENTS FOUND IN PLANTS

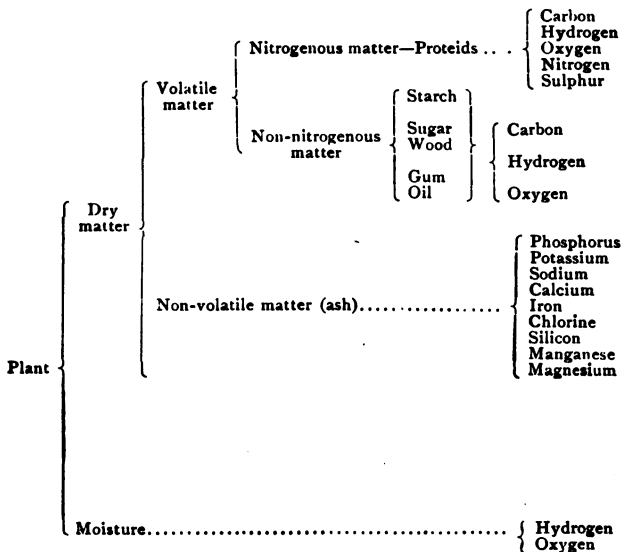
TIME: WHENEVER CONVENIENT

Object: To learn what elements are found in plants.

Material needed: Note-book, pencil.

DIRECTIONS

Study the list of elements in the diagram below.
Notice their grouping.



EXERCISE 73

HOW TO DISTINGUISH FERTILIZER INGREDIENTS

TIME: FALL OR SPRING TERM

Object: To learn how to distinguish the different fertilizer ingredients.

Material needed: Fertilizers of various kinds.

DIRECTIONS

Let the teacher write to the nearest fertilizer company for small samples of rock phosphate, acid phosphate, bone meal, muriate of potash, sulphate of potash, kainit, dried blood, gypsum, Thomas slag, etc. Place them before the class, and let their characteristics be studied until each ingredient can be readily recognized.

Arrange the substances studied in groups according to the kinds of plant food which they contain.

Phosphoric Acid	Nitrogen	Potash
.....
.....
.....

EXERCISE 74

THE EFFECT OF TOO STRONG FOOD SOLUTIONS IN THE SOIL

TIME: WHENEVER CONVENIENT DURING GROWING WEATHER

Object: To determine if plants may be injured by strong food solutions.

Material needed: Flower pot, seeds, salt solution.

DIRECTIONS

1. Select a young plant which has developed its first leaves. Observe its firmness. Place it in a 5 per cent. salt solution for a few minutes; remove from solution and observe the change in its rigidity. How do you account for the change? Immerse the young plant in fresh water for an hour and test again. Does it regain its firmness?

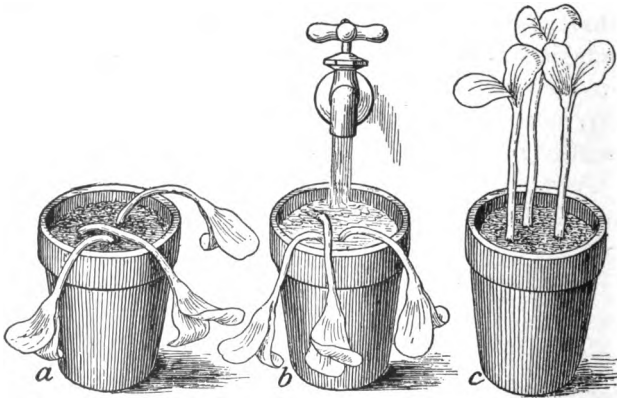


FIG. 25—EFFECT OF STRONG SOLUTIONS ON PLANT GROWTH: *a*, SALT ADDED; *b*, SALT BEING WASHED OUT; *c*, PLANTS REVIVED

2. Plant seeds in a small flower pot. When the plants are 3 inches high, pour a 10 per cent. salt solution upon the soil, using care so as not to let the solution come in contact with the stem or leaves of the plants. After 24 hours note the appearance of the plants. Let a small stream of water run upon the soil for several hours. Note if any change has occurred in the plants' positions.

Explanation.—Often the plant food in the soil is in the form of salts, which, if too strong, cannot be taken up by the plants. Strong solutions of salts injure plants by drawing water from them. We have these conditions in salt marshes, alkali soils, and peat bogs.

EXERCISE 75

EFFECT OF NITROGEN ON THE GROWTH AND COLOR OF PLANTS

TIME: DURING GROWING WEATHER

Object: To find the effect of nitrogen on the growth and color of plants.

Material needed: Flower pots, seeds, sodium nitrate.

DIRECTIONS

1. Plant seeds in two flower pots or boxes, and keep in a warm place until they germinate. Exercise care so as to have the same kind of soil in each pot.
2. Take 1 ounce of sodium nitrate, calcium nitrate, or potassium nitrate and dissolve in 1 gallon of water. Label this "Nitrate solution."
3. Water one pot with well or spring water, the other with the nitrate solution. Watch the growth for three or four weeks. Which grows faster? Note the difference in color.

EXERCISE 76

MIXING FERTILIZERS

TIME: WHENEVER CONVENIENT

Object: To learn how to mix fertilizers in definite proportions.

Material needed: Paper and pencil.

DIRECTIONS

The ingredients of plant food in a complete fertilizer are phosphoric acid, nitrogen, and potash. We often hear of "8-2-2" goods. This means that the fertilizer contains 8 per cent. of phosphoric acid, 2 per cent. of nitrogen, and 2 per cent. of potash.

Suppose you want to mix at home a fertilizer equivalent to the one mentioned above, and wish to use acid phosphate, nitrate of soda, and muriate of potash. You will find the amounts of each ingredient as follows:

$$2,000 \times .08 = 160 \text{ pounds phosphoric acid.}$$

$$2,000 \times .02 = 40 \quad \text{"} \quad \text{nitrogen.}$$

$$2,000 \times .02 = 40 \quad \text{"} \quad \text{potash.}$$

Now, by turning to tables 1, 2, and 3 in the Appendix, you will find that acid phosphate contains 16 per cent. of phosphoric acid; nitrate of soda, 16 per cent. of nitrogen; and muriate of potash, 50 per

cent. of potash. Then the amount of each ingredient is found as follows:

$$\begin{array}{rcl} 160 \div .16 & = & 1,000 \text{ pounds acid phosphate.} \\ 40 \div .16 & = & 250 \text{ " nitrate of soda.} \\ 40 \div .50 & = & 80 \text{ " muriate of potash.} \end{array}$$

Total... 1,330 pounds.

$2000 - 1330 = 670$, the amount of filler or make-weight to be added to bring it to a ton basis. Fine sand or dry dirt, well pulverized, may be used as a filler.

EXERCISE 77

FERTILIZER PROBLEMS

TIME: WHENEVER CONVENIENT

Object: To become familiar with the method of finding the amounts of fertilizer ingredients in any combination.

Material needed: Paper and pencil.

DIRECTIONS

Follow the method used in Exercise 76 and solve the following problems:

1. Work out the amounts of each ingredient in a 10-2-4 fertilizer, using acid phosphate, nitrate of soda, and muriate of potash.
2. What would be the weight of filler in one ton of an 8-2-4 fertilizer, using ground bone, cotton-seed meal, and kainit?
3. With phosphoric acid at 4 cents, nitrogen at 15 cents, and potash at 5 cents a pound, what would a ton of each of the above fertilizers cost?

EXERCISE 78

QUESTIONING THE SOIL

TIME: FALL OR SPRING TERM

Object: To find out the needs of land for maximum crop production by questioning the soil.

Material needed: Tape line, stakes, fertilizers, labels.

DIRECTIONS

1. Lay out 12 plots for a fertilizer test. Let the plots be 2 rods square, and have paths 4 feet wide left between them.

The following diagram shows the arrangement of the plots and the amount of fertilizer ingredients for each:

Nitrate of Soda 150 lbs. per A., 3½ lbs. per plot	No Fertilizer
Acid Phosphate 240 lbs. per A., 6 lbs. per plot	Acid Phos., 240 lbs., 6 lbs. per plot Muriate of P., 80 " 2 " "
Muriate of Potash 80 lbs., 2 lbs. per plot	Nitrate of S., 150 lbs., 3½ lbs. per plot Acid Phos., 240 " 6 " " Muriate of P., 80 " 2 " "
No Fertilizer	Farmyard Manure 10 tons 500 lbs. per plot
Nitrate of S., 150 lbs., 3½ lbs. per plot Acid P., 240 " 6 " "	Farmyard Manure 15 tons 750 lbs. per plot
Nitrate of S., 150 lbs., 3½ lbs. per plot Muriate of P., 80 " 2 " "	No Fertilizer

FERTILIZER EXPERIMENTS

2. Prepare a label for each plot, showing the fertilizer used and the date of seeding. Use the form given in Exercise 31 for keeping the records.

The successful farmer of the future must be an experimenter in a small way.

EXERCISE 79

HOW CLOVER HELPS THE FARMER

TIME: SPRING TERM

Object: To learn how clover and other legumes benefit the farmer.

Material needed: Fruit jar, clover seed, nodules from roots of legumes.

DIRECTIONS

1. Fill a fruit jar almost full of moist garden soil, and in it plant about 50 seeds of common red clover. Screw on the top loosely and place the jar in a warm place. When the plants are well grown, pour in enough water to moisten the soil thoroughly. Gently pull out the plants so as not to injure the roots and find the swellings. Do all the plants have swellings on their roots? Do they vary in size?

2. Repeat the experiment with other types of soil, and note whether there is any variation in

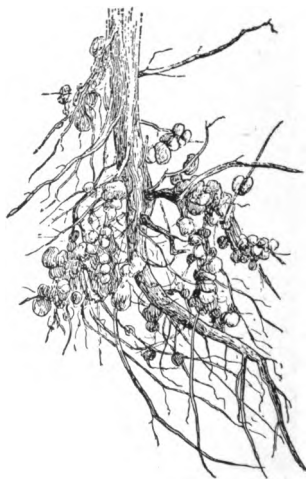


FIG. 26—NODULES ON SOY BEAN ROOTS

the number of nodules on the roots of plants grown in different soils.

3. Make a collection of nodules of other plants, as alfalfa, peas, beans, and vetches. Do you see any variation in the size, form, and number of nodules taken from different plants?

Facts about legumes.—The plants named above are legumes, nitrogen gatherers. The swellings on the roots of these plants are the homes of minute swarms of little beings which are able to change the nitrogen of the air into nitrates for the use of plants. They not only furnish the plants on which they live nitrates for food, but even more than is needed and in this way make the soil fertile. Legumes furnish to the soil the most expensive fertilizer ingredient. Farmers who grow legumes extensively are not compelled, except in rare cases, to purchase a fertilizer containing nitrogen. Many farmers of the South supply nitrogen to the soil in the form of cotton-seed meal.

EXERCISE 80

TESTING SEED CORN

TIME: BEFORE PLANTING TIME

Object: To determine what ears should be used for seed.

Material needed: Germination box, sand, cloth, corn ears.

DIRECTIONS

1. Take a shallow box and partly fill it with sand. Let the sand be as fine as can be procured; it will hold moisture longer than coarse sand, thus rendering the conditions more favorable for germination. Moisten the sand and stir it up with the fingers so the moisture will be uniform. Avoid an excess of moisture, for then the corn would rot. Have it so that no water will run out of the box if it should be tilted. Over the sand place a cloth which has been checked by lines 2 inches apart. Let each square be numbered 1, 2, 3, etc., to correspond with the ears, which are numbered also.

2. Now take each ear separately, and remove four kernels, taking them from different parts of the ear. Take one from the butt, one from the tip and two from the middle; but the middle ones should not be taken together. Turn the ear each time so as not to get them in a straight line. Place the kernels from the different ears in their numbered squares and

cover with a moist cloth to avoid excessive evaporation. Over the cloth place a layer of moist sand. If the sand becomes too dry, sprinkle warm water over it until it is thoroughly moistened; but remember the water must be warm, not hot.

Keep the box at a temperature of about 75° F., and examine it daily. Remove every kernel that sprouts and keep count. Be sure to wait until you are satisfied no other kernels will sprout. Ears whose kernels germinate less than 92 per cent. should not be planted. Do not plant ears whose kernels show a slow, feeble germination.

EXERCISE 81

VARIATION IN INDIVIDUAL EARS

TIME: SPRING AND FALL TERMS

Object: To study and record the variation in individual ears.

Material needed: Space in field, ears of corn.

DIRECTIONS

Select 12 or more good ears for this exercise, and plant in the corn field one ear to the row. Have the rows numbered and plant by hand so it may all be done as nearly alike as possible. Let the ground be uniform in fertility, drainage, etc., so that differences in productiveness in individual ears can be noted. Keep a record of the individual rows, and tabulate your data as follows:

Row No.	Bushels an Acre	Per cent. of Stand	No. Broken Stalks	No. Barren Stalks	No. Suckers



EXERCISE 82

SEED CORN TRANSMITTING CHARACTERISTICS

TIME: SPRING AND FALL TERMS

Object: To determine how far certain characteristics will be transmitted by seed corn.

Material needed: Space in field, ears of corn.

DIRECTIONS

Select one ear each of the following types: large cobs, small cobs, tapering ears, wide space between the rows, cylindrical ears, small ears, and large ears. Number each ear and plant by hand, one ear to a row. Have the rows numbered to correspond to the number of the ear. When the corn has matured, harvest the rows separately and observe whether the row planted with seed from the ear having a large cob has a greater percentage of large cobs than the other rows. Likewise observe the particular characteristic of each individual row.

What resemblance do the plants and the ears bear to the plants which bore the seed and to the ears from which the seed was selected?

EXERCISE 83

MECHANICAL SELECTION OF CORN

TIME: FALL OR SPRING TERM

Object: To study types of corn by mechanical selection.

Material needed: Scales, ears of corn.

DIRECTIONS

1. Take from 1 to 5 bushels of average field corn; divide into large, medium, and small ears. Count and weigh the ears of each lot and record as follows:

	Number	Weight	Bushels	Per centt by Weigh.
Large ears.....				
Medium ears.....				
Small ears.....				

2. Use the same corn and make other divisions named below:

	Number	Per cent. by Number
Long slim ears.....		
Short slim ears.....		
Short thick ears.....		
Ideal ears.....		

	Number	Per cent. by Number
Cylindrical ears.....		
Tapering ears.....		
Well filled butts.....		
Well filled tips.....		

It should not be expected that each student work out all the parts of this exercise. Students should be divided into groups, and allowed to work out some part of the exercise in groups. It would be well to have some of the students repeat the exercise at their homes, and then make a comparison of the results before the whole class.

EXERCISE 84

PER CENT. OF CORN AND COB

TIME: SPRING TERM

Object: To determine whose corn has the greatest percentage of corn to cob, and to find, if possible, the cause of this variation.

Material needed: Scales, ears of corn.

DIRECTIONS

1. Have a limited number of boys weigh and shell, at their homes, a sack or basket of corn. Weigh the shelled corn and calculate the percentage of corn to cob. This should be from 86 to 87 per cent. Note whose corn has the greatest percentage; whose has the least. Can any reasons be given for this variation?

2. Select other students and have them bring to the school 10 ears each of the following types: tapering ears, cylindrical ears, long slim ears, short thick ears, ears with well filled tips, ears with well filled butts, ears with large cobs, and ears with small cobs. Weigh. Shell and find percentage of corn to cob, and record the results as follows:

Name of Student	Type of Corn	Per cent. of Corn to Cob

EXERCISE 85

TYPES OF SEED CORN

TIME: FALL OR SPRING TERM

Object: To learn the characteristics of good and bad ears.

Material needed: Labels, crib of corn.

DIRECTIONS

Study the types of corn in the following cuts and select ears from the crib at your home to represent all the types shown in this exercise.

The following table gives the per cent. of protein, oil, and ash in the three parts of the kernel:

	Per cent. of Protein	Per cent. of Oil	Per cent. of Ash	Total
Germ... ..	19.28	34.6	10.11	63.99
Floury portion.....	7.93	0.8	0.53	9.26
Horny portion.....	10.93	1.03	0.64	12.61

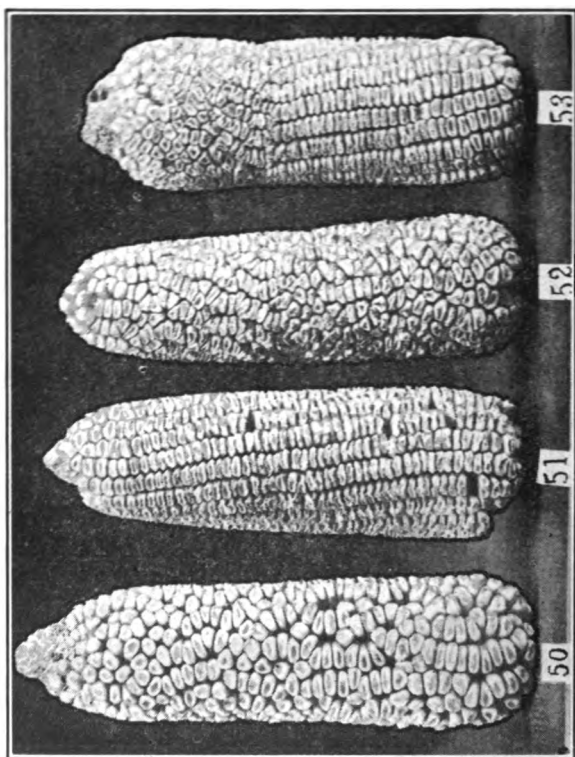


FIG. 27—VERY POOR EARS

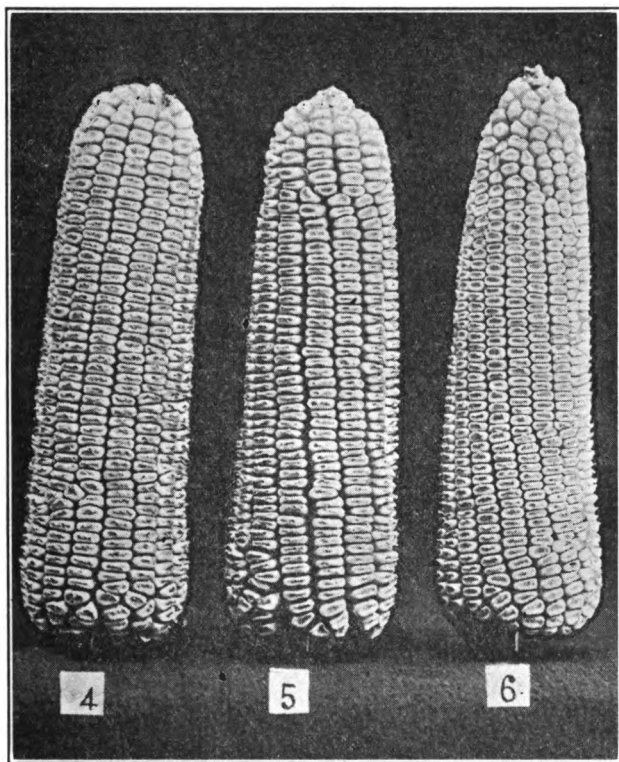


FIG. 28—SHAPE OF EARS

4—cylindrical; 5—tapering; 6—very tapering

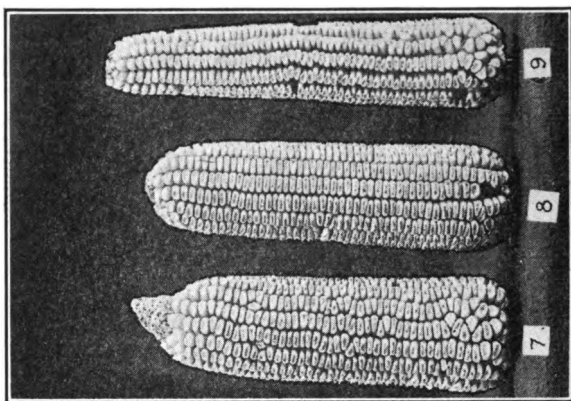


FIG. 30—EARS OF VARIOUS GIRTHS
7—too large; 8—proper girth; 9—too small

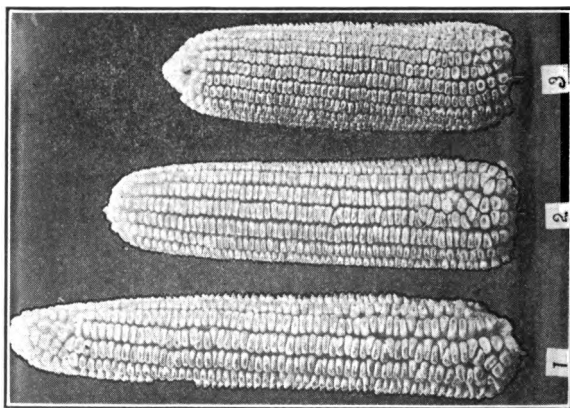


FIG. 29—EARS OF VARIOUS LENGTHS
1—too long; 2—proper length; 3—too short

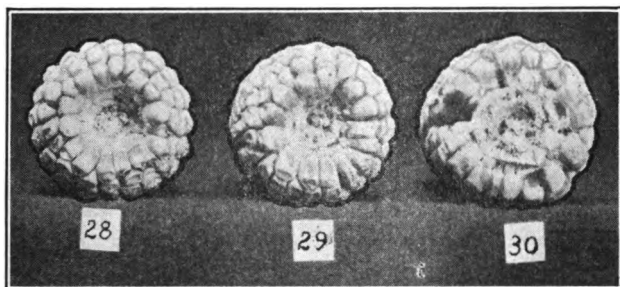


FIG. 31—VARIOUS BUTTS

28—well rounded ; 29—moderately rounded ; 30—shallow rounded

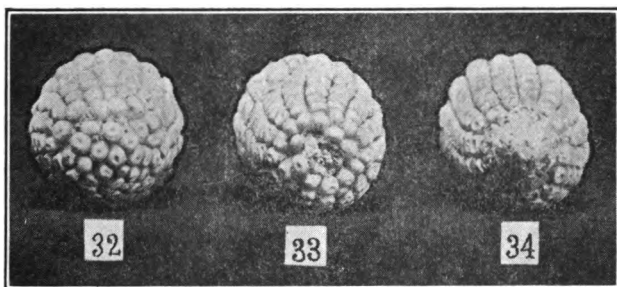


FIG. 32—EAR TIPS

32—well filled ; 33—partly filled ; 34—poorly filled

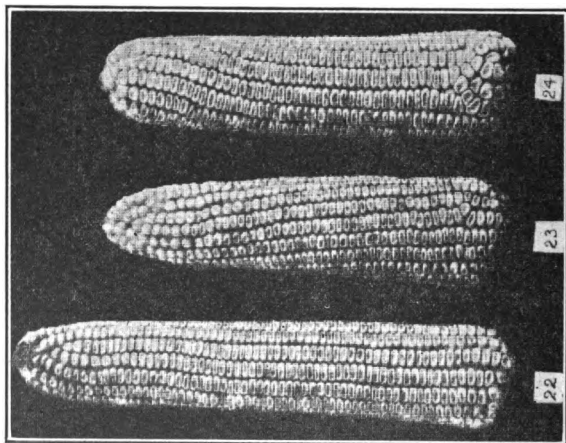


FIG. 33—ARRANGEMENT OF ROWS
22—straight; 23—turn to left; 24—turn to right

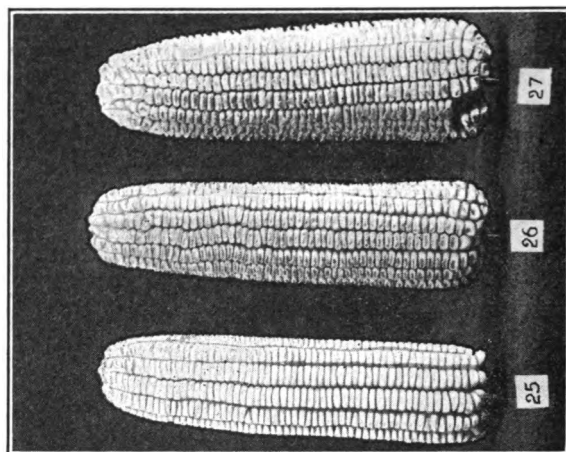


FIG. 34—INDENTATION
25—smooth; 26—medium; 27—rough

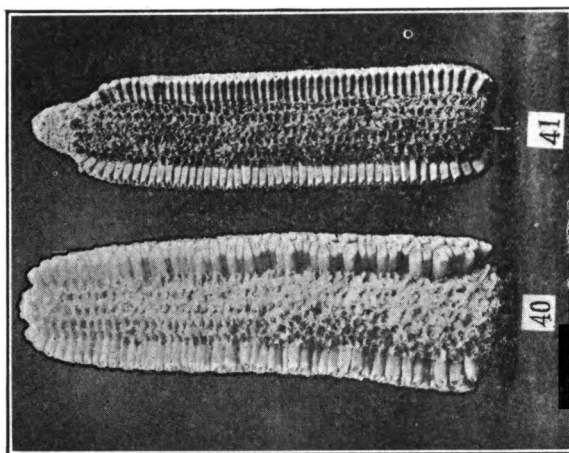


FIG. 36—CLOSELY PACKED KERNELS
Natural shape destroyed in 40, retained in 41

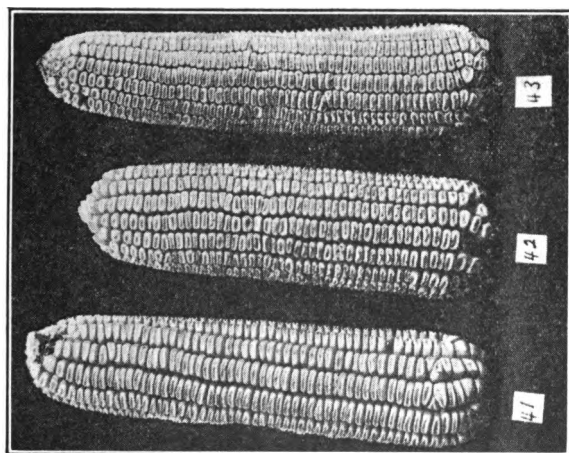


FIG. 35—SPACE BETWEEN ROWS
41—wide; 42—medium; 43—narrow

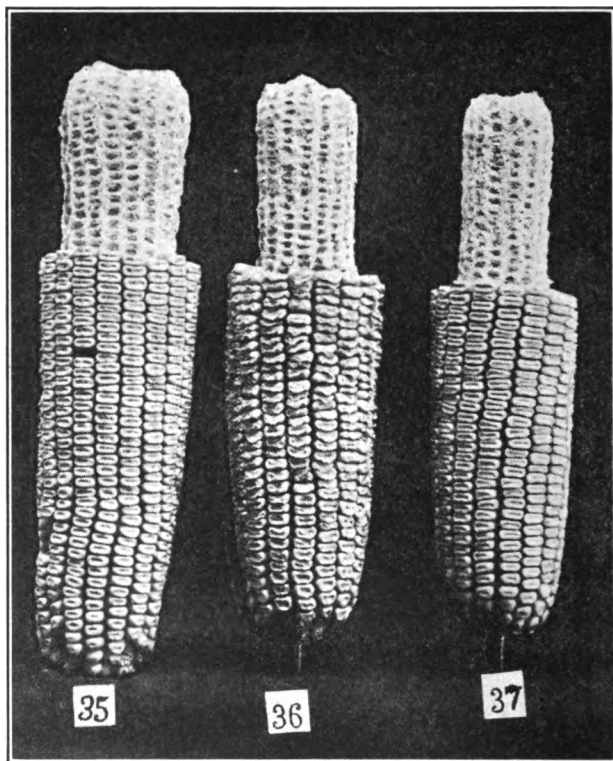


FIG. 37—SIZE OF COB

35—too large ; 36—proper size ; 37—too small

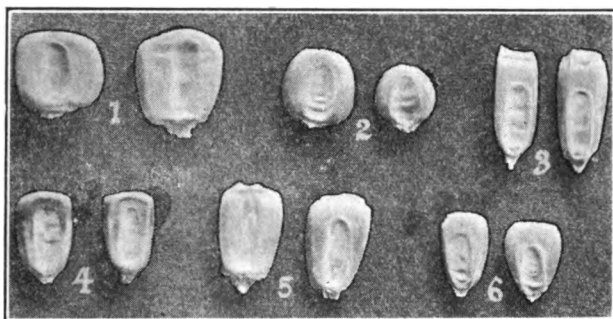


FIG. 38—FORMS OF KERNELS

Pairs 4 and 5 have the best form

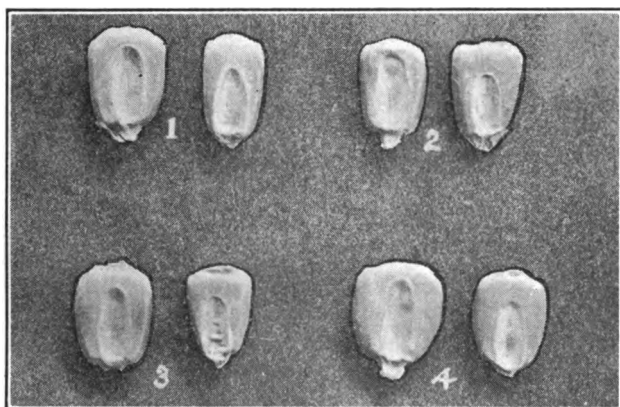


FIG. 39—LARGE AND SMALL GERMS

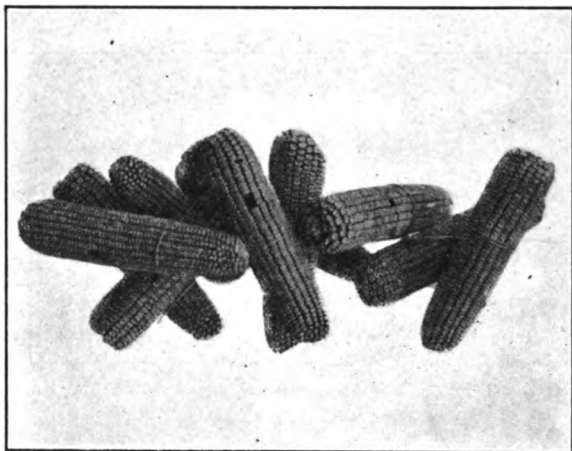


FIG. 41—PRIZE EARS AT AN IOWA STATE FAIR

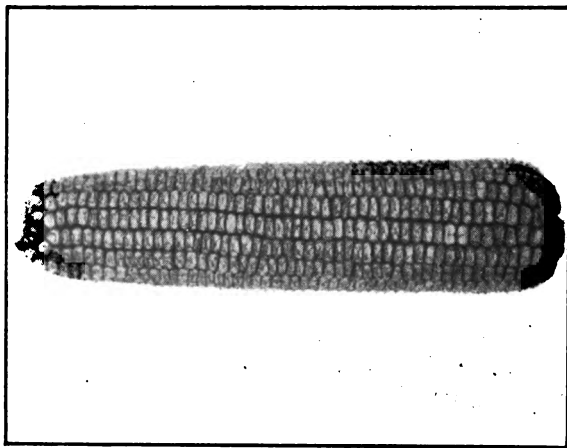


FIG. 40—PRIZE EAR IN AN IOWA CONTEST
(This ear was sold for \$10)

EXERCISE 86

COMPARISON OF KERNELS OF VARIETIES OF CORN

TIME: SPRING TERM

Object: To study the variation in the kernels of varieties of corn.

Material needed: Tape line, varieties of corn, scales.

DIRECTIONS

Study carefully the variation in the kernels of four varieties of corn, and tabulate your data as follows:

VARIATION IN KERNELS

	Names of Varieties			
No. of kernels in 1 pound.....				
Average weight of kernel (decimally).....				
Average length of kernels in inches				
Average width in inches.....				
Average thickness in inches.....				

EXERCISE 87

COMPARISON OF EARLY, LATE, AND MEDIUM STALKS OF THE SAME VARIETY

TIME: WHEN CORN IS FLOWERING

Object: To compare early, late, and medium stalks of the same variety.

Material needed: Corn field, paper tags, bags, twine.

DIRECTIONS

1. Label 40 stalks with paper tags marked "Early stalks," just as the tassels begin to appear. When you think about one half the tassels have appeared, label 40 other stalks; let the labels be marked "Medium stalks." Again when the last tassels are appearing, label 40 stalks with tags marked "Late stalks." When the corn is mature, harvest and compare the yield of each lot.

2. Repeat the same experiment with the silks. Observe closely the degrees of pollination in the different cases.

QUESTIONS

1. Do you find any variation in the yield of early, medium and late stalks?

2. If so, how do you account for this variation?

3. What advantage or disadvantage would there be in having a variety of corn whose silking and tasseling period is short?

4. Are ears of corn from replanted hills better or more poorly filled than those of the main planting?

EXERCISE 88

TASSELING AND SILKING PERIOD

TIME: WHEN CORN IS FLOWERING

Object: To study the range of the tasseling and silking period.

Material needed: Corn field, rule, note-book.

DIRECTIONS

1. For this exercise select a single row of corn; beginning at one end count off 100 hills. Begin the exercise just as the first tassel appears. At a fixed hour each day pass along the row, and count the number of tassels and silks which have appeared. Keep record in note-book, also the days which have rain or sunshine. Continue your observations until there is no longer an increase in the number of silks and tassels.

2. With the chart below as a model, construct a graphic chart showing the tasseling and silking period.

Supposed Data:

Total number of tassels to appear each day:

1—0—6—4—15—10—25—16—8—0—5—0

Total number of silks to appear each day:

0—0—0—3—5—3—5—23—40—28—16—5

Observe that the number of silks or tassels which appear each day is represented by the perpendicular

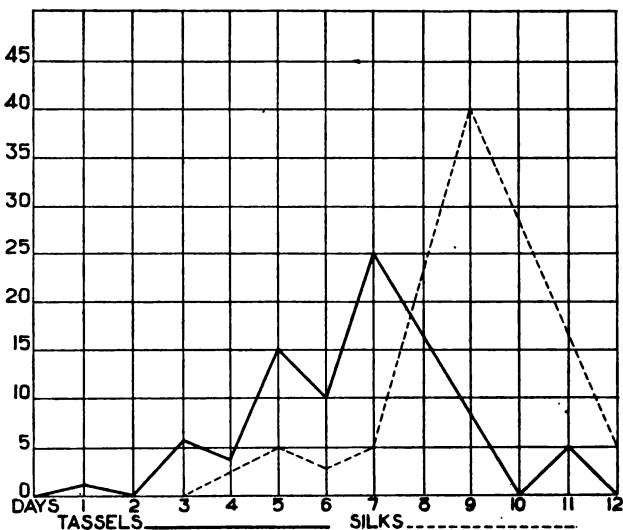


FIG. 42—CHART OF CURVES SHOWING RANGE OF TASSELING AND SILKING PERIOD

line extending from the base of the chart to the curve.

QUESTIONS

1. What is the length of the tasseling period? Silking period?
2. Do you think the number of silks or tassels to appear daily was influenced in any way? If so, by what?
3. Why is there such variation in the time in which silks appear?
4. Which would be of any advantage to the farmer to have, a variety whose silking period is short or long? Why?

EXERCISE 89

PERIOD OF POLLINATION OF CORN

TIME: WHEN CORN IS FLOWERING

Object: To determine at what period during the day pollination is most effective.

Material needed: Corn field, rule, note-book.

DIRECTIONS

1. Cover a large number of shoots just before the silks appear, as in Exercise 91. Beginning with 4 A.M., divide the day into periods of four hours each as follows:

1. First period, 4 to 6 A.M.
2. Second period, 6 to 8 A.M.
3. Third period, 8 to 10 A.M.
4. Fourth period, 10 to 12 M.
5. Fifth period, 12 to 1 P.M.
6. Sixth period, 1 to 3 P.M.
7. Seventh period, 3 to 5 P.M.
8. Eighth period, 5 to 7 P.M.

2. When the silks are 3 or 4 inches long, remove the bags from 10 ears and leave exposed during the first period, then replace the bags and tie. Continue the exposure throughout the eight periods. In removing or replacing the bags, use care so as not to shake the pollen from the stalks. Label each set of exposures, giving date and period.

3. When the corn is harvested, observe the amount of pollination of the ears during the different periods.

QUESTIONS

1. What period is most favorable for fertilization?
2. When does the corn flower open?

EXERCISE 90

EFFECT OF WIND ON THE POLLINATION OF CORN

TIME: WHEN CORN IS FLOWERING

Object: To learn how much the wind affects the pollination of corn.

Material needed: Corn field, rule, note-book.

DIRECTIONS

1. Cover two dozen shoots just before the silks appear, as in Exercise 91. When the silks are in the receptive stage, which can be told by the length, select a time during the day when there is a rather brisk breeze and expose 12 silks a certain number of hours. On another day, when the air is still, expose the other set of 12 the same number of hours. Replace the paper bags in each case and label the two sets, giving date, length of exposure, and treatment.

2. When the corn has been harvested note any variation in the degree of pollination of the two sets.

EXERCISE 91

RECEPTIVE STAGE OF SILKS

TIME: WHEN CORN IS FLOWERING

Object: To find the stage in which silks are ready to receive the pollen.

Material needed: Corn field, rule, note-book.

DIRECTIONS

1. Tie paper bags over 12 or more young shoots just before the silks appear. Apply pollen to three of the shoots just as the first silks put in appearance; treat other sets of three in the same way when the silks are 2, 4, and 6 inches long. Leave the fourth set 10 days after the silks appear before applying the pollen, but keep covered all this time. The pollen should be applied early in the morning, say between six and eight o'clock. This can be done by removing the paper bag and shaking over the silk a tassel which is shedding its pollen in abundance. After this is done, replace the bag and tie as before. The treated ears should be watched every two or three days so as to loosen the strings in case they are interfering with the growing ear. Each stalk should bear a label showing the date of pollination and the length of silk when treated.

2. When the corn has matured, harvest the treated ears and observe the degree of pollination

in each set. Draw a conclusion as to the receptive stage. How long were the silks in the last set pollinated? Why did they grow to such length? . Observe the position of the kernels in each set. In which set are the butts, tips, and middle portions of the ears best filled?

EXERCISE 92

THE EFFECT OF DETASSELING CORN UPON THE YIELD

TIME: WHEN CORN IS FLOWERING

Object: To find whether removing the tassels as they appear affects the yield.

Material needed: Corn field, labels, knife.

DIRECTIONS

1. Select a field of uniform fertility, drainage, etc. Use from 24 to 50 rows in this exercise and cut out the tassels as they appear from every other row. Exercise care so as not to cut out any of the blades. You will find a wide range in the tasseling period which will necessitate going over the rows two or three times. Label all the detasseled rows.

2. When the corn is mature, harvest the detasseled rows separately and note the yield. Do likewise with the rows not detasseled.

QUESTIONS

1. Do you find any difference in the yield?
2. Do you observe any difference in the degree of pollination of the detasseled and undetasseled rows?
3. Would there be any advantage in detasseling weak or barren stalks?

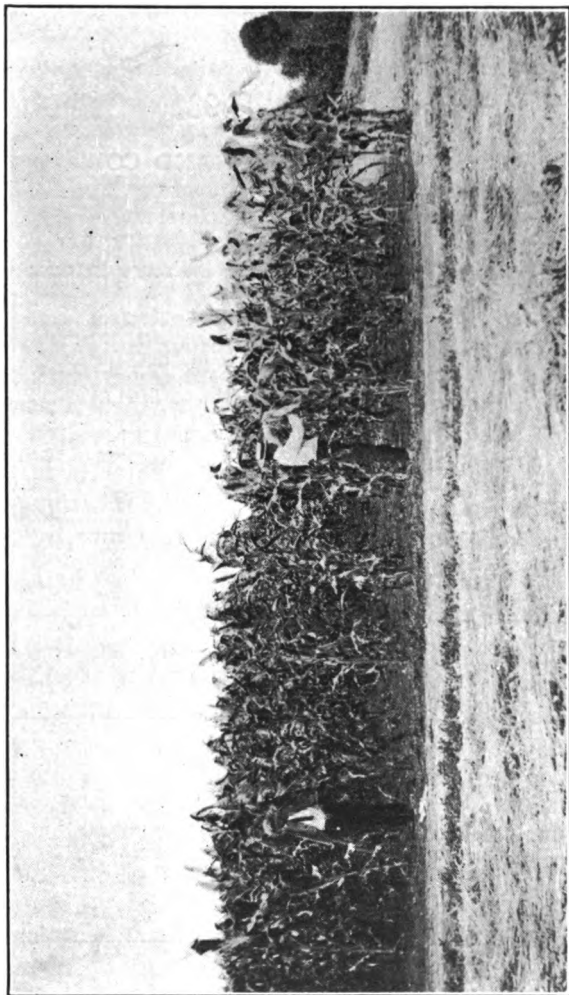


FIG. 43—DETASSELING CORN

EXERCISE 93

MOISTURE IN CORN AND COB

TIME: WHEN CORN IS HARVESTED

Object: To find the amount of moisture in corn and cob at harvesting time.

Material needed: Corn ears, scales, pans.

DIRECTIONS

Weigh six ears of corn; shell and weigh the grain. Place the grain and cobs separately in two bread pans, and dry in a stove until the weight becomes constant. Calculate total moisture in corn and cob and record data as follows:

Weight of Corn before Drying	Weight of Cobs before Drying	Weight of Corn after Drying	Weight of Cobs after Drying	Per cent. of Moisture in Corn	Per cent. of Moisture in Cobs

EXERCISE 94

INFLUENCE OF A MISSING HILL UPON THE YIELD OF ADJOINING STALKS

TIME: WHEN CORN IS READY FOR HARVESTING

Object: To determine whether a missing stalk affects the yield of the stalks adjoining.

Material needed: Corn field, sacks, scales.

DIRECTIONS

Select a field in which the corn has been uniformly planted. Pass through the field hunting for missing stalks, and when one is found, harvest the ears from the stalks in the same row on each side of the missing one. Now step across one row, to the right or left, and select a stalk not adjoining a missing one; harvest the ears on the stalks on each side of the selected one in the same row. Understand there must be only one row between the two classes of selections, lest differences in the soil affect the yield. Keep each class in separate sacks until you have harvested 100 ears of each, or have passed over 50 missing hills. Husk and weigh the two lots. Does the missing stalk increase or diminish the yield of the two adjoining?

The diagram given below shows what hills to harvest.

*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	<i>x</i>	*	*	*	*	<i>x</i>	*	*	*	*	*
		1		1			3		3				
*	*	*	*	*	*	*	*	*	*	*	*	*	*
*	*	*	*	*	*	*	*	*	*	*	*	*	*
		2		2			4		4				
*	*	*	*	*	*	*	*	*	*	*	*	*	*

x's represent the missing hill.

*'s represent the hills.

Figures are placed under the hills to be harvested.

EXERCISE 95

THE EFFECT OF CORN SMUT UPON THE YIELD

TIME: FALL TERM

Object: To find how much corn is affected even when smut does not attack the ear.

Material needed: Cornfield, sacks, scales.

DIRECTIONS

Harvest ears whose stalks are affected by smut. Discard the ears affected by smut, as we should naturally expect the yield to be low when the ears have smut. Every time an ear is pulled from an affected stalk, pull an ear from the nearest stalk regardless of size and keep in a separate sack. Weigh the two lots separately and note the difference in the yield.

QUESTIONS

1. Why is smut classed as a parasite?
2. If it produces no flowers, how does it reproduce?
3. What part of the corn plant is usually most affected?
4. Why does one stage of smut appear as a dark mass?

EXERCISE 96

EFFECT OF METHOD OF HARVESTING MAIZE

TIME: FALL TERM

Object: To find how methods of harvesting corn affect the yield.

Material needed: Knife, labels, scales.

DIRECTIONS

When fodder is ready for pulling, select a part of the field where the corn is as nearly uniform as possible; select 100 hills for each method of treatment and treat as follows: Strip the blades from the stalk; remove the stalk above the ear; cut the whole stalk and shock; and leave the last 100 hills untouched.

Label the four lots. When the corn is ready for harvesting, husk and weigh each lot separately. Tabulate results as follows:

Method of Treatment	Number of Pounds	Loss or Gain in Pounds
Blades stripped..... ..		
Topped above the ear..... ..		
Stalks cut and shocked..... ..		
Left standing, untreated..... ..		

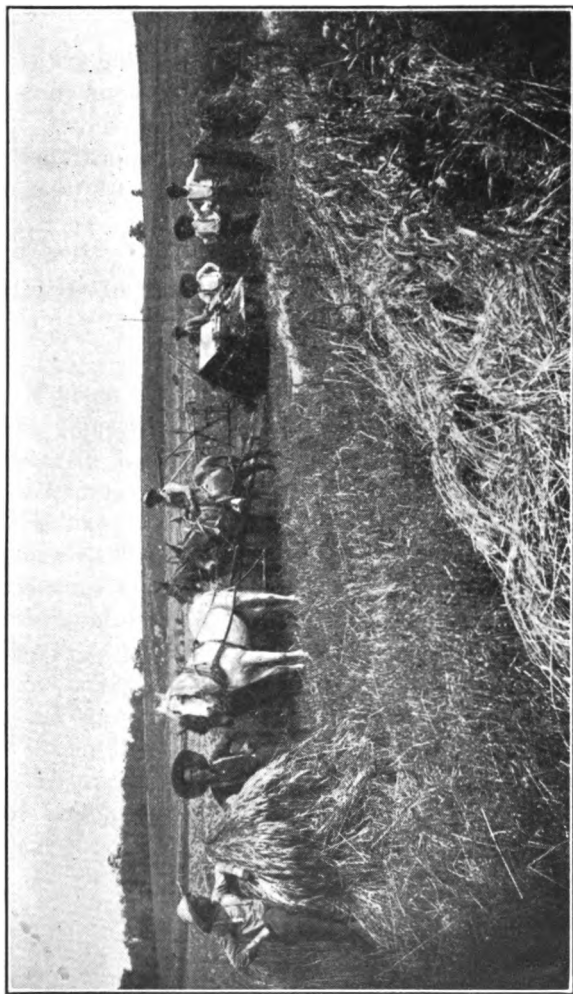


FIG. 44—HARVEST SCENE

"The earth is a machine which yields almost gratuitous service to every application of intellect."—*Emerson*.

QUESTIONS

1. Which is the best method of harvesting corn?
2. What method is commonly used in your community?
3. Can you see any difference in the appearance of the corn under the different methods of treatment?

EXERCISE 97

GLUTEN IN FLOUR

TIME: WHENEVER CONVENIENT

Object: To find the gluten in flour.

Material needed: Muslin bag, flour.

DIRECTIONS

Moisten some ordinary wheat flour with water and place it in a muslin bag. Allow a stream of water to flow through the bag while kneading with the fingers; catch the milky fluid in a vessel. Continue the washing until the water is almost clear. You will have remaining in the bag an elastic substance of a creamy color which is called gluten. It is the gluten in the flour which makes dough. Gluten is also the proteid of the wheat. It forms about 10 per cent. of the flour, while the starch forms about 75 per cent.

The milky fluid that was washed from the flour is the starch. Take a small portion of this and test for starch. Add a drop of iodine to it, and if it turns to a blue color, you may know that it is starch.

EXERCISE 98

RELATION BETWEEN LENGTH OF STRAW AND YIELD OF GRAIN IN WHEAT

TIME: WHEN WHEAT IS RIPE

Object: To determine whether there is any relation between length of straw and yield of grain in wheat.

Material needed: Wheat field, knife, scales.

DIRECTIONS

When wheat is ripe, go into the field and harvest 100 stalks each of long, medium, and short straw. Cut every straw even with the ground and weigh the lots separately.

Thresh the grain with the hands (will take only a short time), blow out the chaff, weigh the grain separately, and tabulate results as follows:

	Weight of Straw and Grain	Weight of Straw	Weight of Grain	Per cent. of Straw	Per cent. of Grain
Long straw					
Medium "					
Short "					

The same investigations may be carried on with rye and barley.

EXERCISE 99

RELATION BETWEEN THE LENGTH OF HEADS OF WHEAT AND NUMBER OF STALKS AN ACRE

TIME: WHEN WHEAT IS RIPENING

Object: To determine the relation between the length of head of wheat and the number of stalks an acre.

Material needed: Wheat field, wire hoops, rule.

DIRECTIONS

1. Place a wire hoop of known area over the heads of wheat, and let it slip down to the ground. The hoop must include every stalk that will stand within the hoop without being pressed in or forced. Count the number of stalks within the inclosure, and find the average length of heads within the hoop. This can be done by measuring several heads, adding the length and dividing by the number measured.

2. Repeat this in several parts of the field. Tabulate results as follows:

Number of Trials	Area of Hoop	Number of Stalks in Hoop	Number of Stalks per Acre	Length of Head
1.				
2.				
3.				
4.				
5.				
6.				

Is there any relation between the number of stalks an acre and length of head?

EXERCISE 100

PREVENTING OAT SMUT

TIME: FEBRUARY OR MARCH

Object: To show how to prevent oat smut in the succeeding crop by treating the seeds with formaldehyde before they are sown.

Material needed: Formaldehyde, oats, two plots.

DIRECTIONS

Purchase at the drug store 1 ounce of formaldehyde, which will cost about 5 cents. Pour it into about 3 gallons of water and stir. Sprinkle this preparation on the seeds until they are thoroughly saturated; spread the oats out thinly and let them dry.

Sow equal amounts on two adjoining plots, but let one plot be seeded with treated oats, the other with untreated oats.

At harvest time, count the number of smutted heads in the treated and the untreated plots.

EXERCISE 101

QUALITY OF OATS

TIME: FALL OR SPRING TERM

Object: To find who has the best oats in the community.

Material needed: Half-bushel measure, oats, scales.

DIRECTIONS

Have several pupils weigh out 1 bushel of oats at their homes and bring weights to school. In measuring out the oats, draw a straight edge over the half-bushel, leaving the grain even with the top. Let the pupils tabulate their results as follows:

Students' Names	Weight of Bushel	No. Pounds Overweight	Per cent. Overweight	Variety

Each student should copy the data of all the others.

EXERCISE 102

BOTANICAL STUDY OF THE COTTON PLANT

TIME: WHEN COTTON IS FLOWERING

Object: To learn some of the botanical characteristics of cotton.

Material needed: Cotton plant.

DIRECTIONS

Select a blooming cotton plant, study carefully and fill the blanks outlined below:

- Root: Fibrous or tap-rooted?.....
Deep or shallow?.....
- Stem: Erect or trailing?..... Shape of stem.....
Color of bark..... Color of wood.....
- Leaves: Alternate or opposite?..... Shape.....
Number of lobes..... Make drawing showing veins.
- Calyx: Size..... Shape.....
- Corolla: Color..... Shape..... Size.....
- Petals: Number..... Separate or coalescent?.....
- Stamens and pistils: Number of each.....
Make drawings of stamens and pistils.

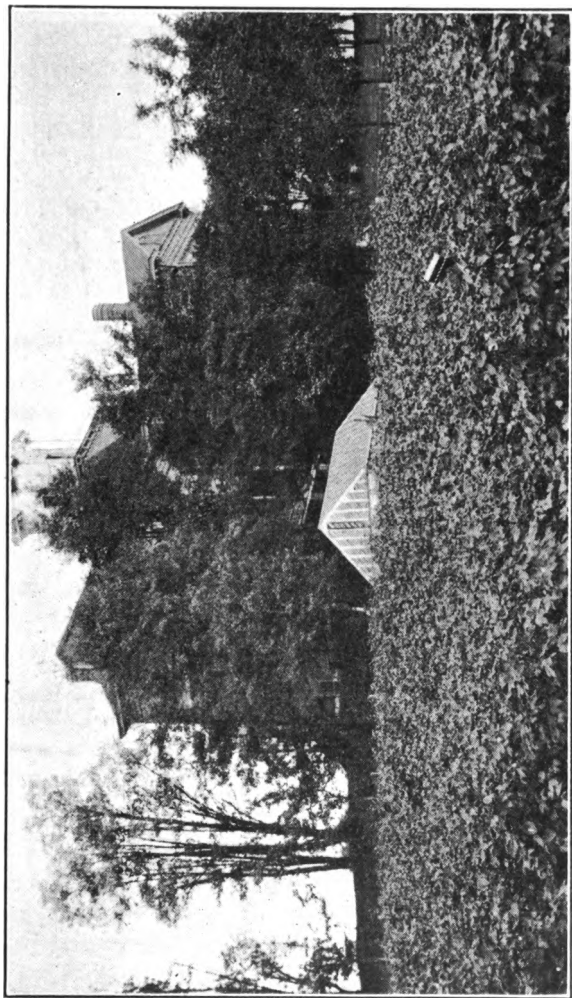


FIG. 45—COTTON, SHOWING LUXURIANT GROWTH

EXERCISE 103

PROPORTIONS OF DIFFERENT PARTS OF THE COTTON PLANT

TIME: FALL TERM

Object: To find the proportion of roots, stems, leaves, bolls, etc., of the cotton plant.

Material needed: Ten cotton plants, hoe, knife, scales.

DIRECTIONS

1. When cotton is opening dig up 10 plants, taking care to obtain as much of the root system as possible. Separate the roots, stems, leaves, bolls, seed, and lint of the 10 plants.

2. Weigh and tabulate results as follows:

Parts of the Plant	Weight		Per cent.
	Ounces	Grams	
Roots			
Stems			
Leaves			
Bolls			
Seed			
Lint			
Total (ten plants)			
Average (one plant)			

EXERCISE 104

COMPARISON OF LARGE, MEDIUM, AND SMALL PLANTS

TIME: WHEN COTTON IS READY FOR PICKING

Object: To study the variation in yield and number of bolls of plants of different sizes.

Material needed: Cotton field, scales.

DIRECTIONS

1. Select 25 plants each of large, medium, and small, and count the number of bolls in each set.
2. Pick the lint from each set of 25 plants, weigh, and tabulate your results as follows:

	Total No. of Bolls	Average No. Bolls per Plant	Total Weight Seed Cotton	Average Weight per Plant	No. Plants to produce 1,500 Pounds
Large.....					
Medium					
Small.....					

QUESTIONS

1. From which set would you select seed for the next year's crop? Why?
2. Do you see any relation between the yield of seed cotton and the number of bolls to the plant?
3. Is there any relation between the size of the bolls and the size of the plant?

EXERCISE 105

VARIATION IN NUMBER OF BOLLS TO THE PLANT

TIME: WHEN THE BOLLS ARE OPENING

Object: To find and represent graphically the variation in the number of bolls of cotton per plant.

Material needed: Cotton field, note-book, rule.

DIRECTIONS

Begin at the end of a row and count the number of bolls on each of 25 plants, taking them as they come in the row.

Construct a graphic chart showing variation in the number of bolls of the 25 plants which you have studied. Use the chart below as a model.

NUMBER BOLLS

Supposed data: 50—22—10—35—48—75—85—100—76—40—
9—30—40—45—25—66—50—48—20—10.

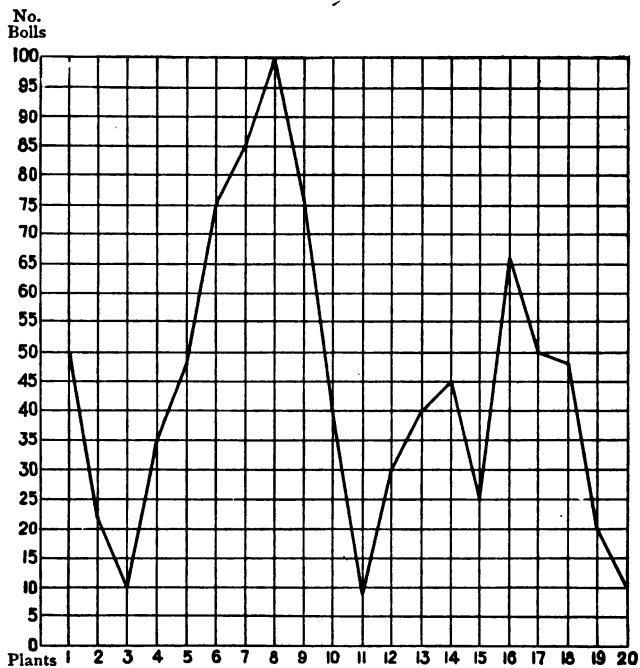


FIG. 46—CHART SHOWING YIELD OF BOLLS

EXERCISE 106

AN IDEAL COTTON PLANT

TIME: WHEN COTTON IS READY FOR PICKING

Object: To learn the characteristics of an ideal cotton plant, and the use of the score card for cotton.

Material needed: Cotton plants, score card.

DIRECTIONS

1. Study carefully the description of an ideal cotton plant given below. Let each student bring from the home farm that plant that he thinks approaches nearest this ideal.
2. With the use of the score card and directions for judging cotton given in the Appendix, determine what student has found the best plant.

THE IDEAL COTTON PLANT*

"If a careful observer went through any cotton field last fall he must have noticed some very inferior plants, a great many fairly good plants, and a few which were decidedly superior to these. The inferior plants were not all so on account of a lack of food nor from improper cultivation; but rather they were inferior because they were built in accord with an inferior model. The great number of fairly good plants were built in complete accord

*By Professor Johnson, University of Georgia.

with neither the inferior nor superior models. In general form they occupied an intermediate position. The few superior plants, those bearing large numbers of well shaped, large bolls, were built according to a distinct plan which seems to characterize plants of greater vigor and productiveness.

"In the average field the inferior plants bear only a few, generally two or three bolls. The average plant may bear as many as 12 to 15 bolls of fairly good size and form, while the few really superior plants many mature as many as 60 to 100 large, well shaped and filled bolls.

"Now let us see something in regard to the general characteristics of these more productive plants.

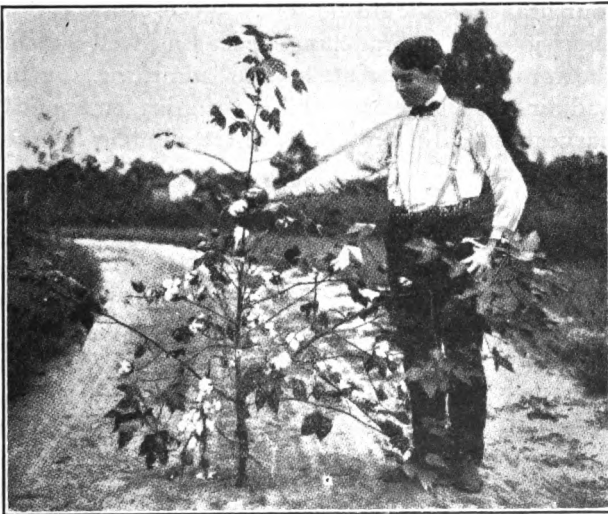


FIG. 47—AN IDEAL COTTON PLANT

(Year Book, U. S. Dept. Agriculture.)

"First to be noted is that there is no one variety possessing all of the good plants, neither does any single variety contain all the inferior ones. In each and every variety there are some good plants so far as that particular variety goes; there are also many poor individuals. There are both the desirable and undesirable in each and every variety.

"The good or more productive plants in any variety will be found to have certain individual and group characteristics, which to some extent may be those of the variety type.

"The best plants are of medium height, with stalks rather thick at the base, tapering gradually, and uniform from base to apex, with good, strong, well defined and closely set joints. The lower three or four branches should be rather close to the ground, short-jointed, re-branching, spreading well out from the central shoot or stalk, thus admitting sunshine and air, which are essential in bringing an abundant harvest to maturity. Above first or main branches others gradually decreasing in length should be arranged at ever increasing distance toward the top of the main stalk. Picture for a moment a plant of this form well laden with good large bolls of cotton, some open ready for the picker, others just beginning to part the tips, while still others retain the deep color characteristic of health and vigor.

"Small plants will not be able to make and mature bolls enough to give a good satisfactory yield. Exceptionally large ones use too much of their life and energy in making foliage and stem, and not enough in making fruit, or if fruit is produced, it is

apt to be so late that much of it will fail to mature properly. The long-jointed plant will not set bolls enough, neither will the one with short branches clear to the ground. The one with long branches well up toward the top of the stalk does not get sunshine and air during the early ripening period, hence the harvest may be unduly delayed, and consequently the crop is injured.

"The ideal plant should approach in general shape a cone whose diameter at the base is equal to three-fourths of its altitude. This gives a strong, well balanced, open-headed plant."

EXERCISE 107

IMPROVEMENT OF COTTON BY SELECTION

TIME: SPRING AND FALL TERMS

Object: To improve productiveness of cotton by seed selection.

Material needed: Field and equipment for cotton cultivation.

DIRECTIONS

The following diagram* illustrates the method of selecting cotton for a period of five years. If followed carefully, using the utmost care in selection, one should improve one's cotton seed wonderfully, and thus greatly increase the yield. It will be observed from this diagram that a start is made with one plant. Let this plant be strong and vigorous, and be given special attention as to the number and size of bolls, length of lint, earliness, and yield. Having selected the best plant, plant all the seed in a small plot the next year. From this small plot select the best plant, as in the first case, and plant the seed from the other plants in the five-acre plot. This five-acre plot will produce the third year enough seed to plant the general crop the following year. Continue the selection, as shown by the diagram, for five years or more.

*From Year Book, U. S. Department of Agriculture.

EXERCISE 108

COMPOSITION OF FARM PRODUCTS

TIME: FALL OR SPRING TERM

Object: To learn by comparison the relative amounts of the constituents of farm products.

Material needed: Paper and pencil.

DIRECTIONS

Having been given the composition of various farm products by the instructor, draw a diagram showing the relative amounts of each constituent.

DIAGRAM SHOWING COMPOSITION OF CORN

Nitrogen-free extract 78.4%		
Protein 11.6%		
Fat 5.8%	F.	A. Fiber, 2.5% Ash, 1.7%

Example:

COMPOSITION OF CORN

Nitrogen-free extract.....	78.4%
Protein	11.6%
Fat	5.8%
Fiber	2.5%
Ash	1.7%
<hr/>	
Total	100.0%

EXERCISE 109

FERTILIZER CONSTITUENTS IN AMERICAN FEEDING STUFFS

TIME: FALL OR SPRING TERM

Object: To learn the relative amounts of fertilizer constituents in 1,000 pounds of American feeding stuffs.

Material needed: Paper and pencil.

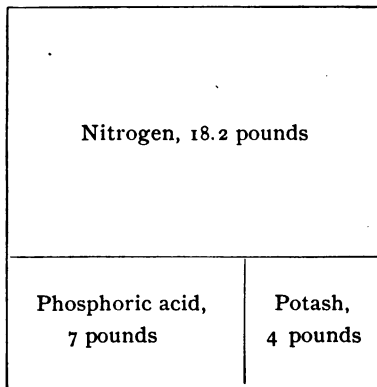
DIRECTIONS

From the table in the appendix draw diagrams showing the relative amounts of fertilizer constituents in 1,000 pounds of feeding stuffs.

Example:

FERTILIZER CONSTITUENTS IN 1,000 POUNDS OF CORN
Nitrogen18.2 lbs.
Phosphoric acid..... 7.0 "
Potash 4.0 "

DIAGRAM SHOWING FERTILIZER CONSTITUENTS IN CORN



EXERCISE 110

FEEDING HAY TO HORSES

TIME: SPRING OR FALL TERM

Object: To determine whether the farmer commonly feeds too much hay to his horses.

Material needed: Two horses at home, hay, grain.

DIRECTIONS

For this exercise have pupils use two horses at their homes. Keep in separate stalls and feed one horse all the hay he will eat. Considerably reduce the amount of hay given to the second horse, but feed each horse the usual grain ration.

Keep this up for several days and see if the horse which has been given a smaller amount of hay does not have as much flesh, appear livelier, and travel better than the other one.

Horses when given large quantities of hay are apt to have the heaves.

EXERCISE 111

CALCULATING RATIONS FOR ANIMALS

TIME: FALL OR SPRING TERM

Object: To learn how to balance rations so as to keep the animal in good condition and to practice economy in feeding.

Material needed: Paper and pencil.

Explanations.—Feeding stuffs contain protein, carbohydrates, and fat. The percentages of these ingredients are found in Table V. of the Appendix. By the nutritive ratio is meant the proportion of protein to carbohydrates and fat combined. The following formula shows the method of obtaining the nutritive ratio:

$$\frac{(\text{Fat} \times 2.4) + \text{carbohydrates}}{\text{Protein}} = \text{nutritive ratio}$$

In calculating the ratio, we multiply the fat by 2.4; for the fat is nearly $2\frac{1}{2}$ times as valuable for food as the carbohydrates.

DIRECTIONS

Let us find the nutritive ratio of the following ration:

Clover hay.....	15 pounds
Oats	6 pounds
Cotton-seed meal.....	3 pounds

Multiply each ingredient by the per cent. of protein, carbohydrates and fat.

Protein	Carbohydrates	Fat
$15 \times 7.6 = 1.140$	$15 \times 38.4 = 5.760$	$15 \times 2.0 = .30$
$6 \times 9.2 = .552$	$6 \times 47.3 = 2.838$	$6 \times 4.2 = .252$
$3 \times 38.1 = 1.143$	$3 \times 16 = .480$	$3 \times 12.6 = .378$
<u>2.835</u>	<u>9.078</u>	<u>.930</u>
	<u>2.232</u>	
	11.310	$.93 \times 2.4 = 2.232$
$11.310 + 2.835 = 3.9$	Nutritive ratio 1 : 3.9	

EXERCISE 112

CALCULATING RATIONS FOR ANIMALS (*Continued*)

TIME: FALL OR SPRING TERM

Object: To learn how to balance rations for different animals under different conditions.

Material needed: Paper and pencil.

DIRECTIONS

Select your own feeds and balance rations for the animals mentioned in the table below. The number of pounds of dry matter and the nutritive ratios are given in the same table.

POUNDS OF FOOD REQUIRED A DAY FOR 1,000 POUNDS LIVE WEIGHT

Kind of Animal	Total Dry Matter	Nutritive Ratio
Oxen at rest.....	18	1 : 12
Oxen at moderate work.....	25	1 : 7
Fattening cattle.....	28	1 : 6
Milch cows.....	28	1 : 5.5
Sheep, growing wool.....	20	1 : 8
Fattening sheep.....	20	1 : 6
Horses, moderate work.....	22	1 : 7
Horses at hard work.....	26	1 : 6
Fattening swine.....	32	1 : 6

EXERCISE 113

FEED AFFECTING THE FLAVOR OF MILK

TIME: SPRING TERM

Object: To learn how feeding stuffs affect the flavor of milk.

Material needed: Rape, cow, milk.

DIRECTIONS

Ask some student, on whose father's farm rape is grown, to feed one of the milch cows some rape in the afternoon, and to save a small amount of milk at milking time. Carry the milk to school and see whether the students can detect any change in the flavor due to the rape.

QUESTIONS

1. Name some other substances that produce bad flavors in milk.
2. Is milk a direct product of food or the blood?
3. At what time does grass most affect the flavor of milk?

EXERCISE 114

SOURING OF MILK

TIME: FALL OR SPRING TERM

Object: To find a means of preventing the souring of milk.

Material needed: Several small milk bottles, milk, thermometer.

DIRECTIONS

1. Clean several small bottles and dry them in the sun. Fill the bottles with fresh milk and divide into three lots. Stopper well so as to exclude the air.
2. Boil one lot for a few minutes. This boiling should kill nearly all the bacteria.
3. Pasteurize the second lot, i.e., place the bottles of milk in water which has been heated to 155° F. Leave 20 minutes and set aside to cool. Leave the third lot untreated.

QUESTIONS

1. How long does the milk keep sweet in each lot?
2. Does boiling or pasteurizing alter the flavor of milk?

EXERCISE 115

A TEST FOR FORMALIN IN MILK

TIME: WHENEVER CONVENIENT

Object: To determine whether milk has been treated with formalin.

Material needed: Milk, formalin, sulphuric acid.

DIRECTIONS

Pour a small amount of formalin into a glass of milk and stir. Next pour sulphuric acid into the milk, letting it run down the side of the glass. Do the same with some milk which has no formalin in it. A purple color at the junction of the milk and acid indicates the presence of formalin. Persons living in the city should occasionally test their milk for formalin, as many milkmen use it to prevent their milk from souring. Pasteurizing is legitimate, but the use of formalin should be condemned. Milk treated with formalin is very harmful to infants.

EXERCISE 116

TEMPERATURE FOR CHURNING BUTTER

TIME: DURING WARM WEATHER

Object: To determine whether a high or a low temperature is better for churning butter.

Material needed: Milk ready for churning, churn, hot water, cold water, thermometer.

DIRECTIONS

Have older pupils at whose homes large quantities of butter are made divide the cream into two parts. Churn one lot at about 58° or 60° , and the other at, say, 80° to 85° . With the aid of a thermometer the temperature can be regulated by hot and cold water. When the two lots have been churned, note any difference in the appearance of the butter.

QUESTIONS

1. Which lot was longer in churning?
2. What difference do you notice in the granular structure?
3. Why is cream usually kept in a warm place before churning?

EXERCISE 117

DIRECTIONS FOR USING THE BABCOCK TEST

TIME: WHENEVER CONVENIENT

Object: To learn the method of testing milk for butter fat by the use of the Babcock test.

Material needed: Babcock tester with equipment, samples of milk.

DIRECTIONS

1. Ask students and patrons for funds to purchase a Babcock tester for the school. One can be bought for \$5.

2. Let students bring fresh milk from their homes to be tested. Samples should be taken while the milk is still warm after it has been thoroughly mixed.

3. When the milk has been well mixed measure out with a pipette 17.5 cubic centimeters and put into the bottles. Blow in the upper end of the pipette to expel all the milk.

4. Measure out an

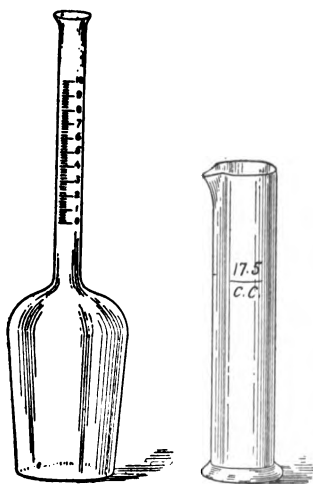


FIG. 48—BOTTLE AND MEASURE

equal amount of acid for each bottle, holding the bottle slantingly; let the acid run down the side of the bottle so as not to come in contact with the milk too suddenly, lest the milk be acted upon unevenly. Gently shake the bottles in the hands until the acid and milk are thoroughly mixed. The mixture will become hot and change to a dark brown. Care must be taken in handling the acid so as not to get any on the skin or clothing: drop a little on a rag and find out why.

5. Place an even number of bottles in the machine, replace the cover, and rotate about 700 to 1,200 revolutions a minute for six or seven minutes.

6. Add enough hot water to bring the mixture up to the bottom of the neck; place the bottles back in the machine and rotate again for three minutes. Now add more hot water and bring the fat up in the neck where it can be measured. Suppose the bottom of the fat column stands at the figure 2 and the top at the figure 6, this would show 4 per cent. of fat. Each per cent. means one pound of butter fat in 100 pounds of milk.

EXERCISE 118

DECAY IN APPLES

TIME: WHENEVER APPLES ARE OBTAINABLE

Object: To show that apples should not be shaken from the tree if they are to be kept.

Material needed: Three ripe apples.

DIRECTIONS

Select three apples of the same variety and of the same degree of ripeness. Strike one against an object so as to bruise one side without breaking the skin; strike another so that the skin is just broken, and leave the third uninjured. Place the three apples somewhere in the room where they will not be disturbed, and examine from time to time.

QUESTIONS

1. Which decays first?
2. What is the function of the skin of an apple?
Select two apples of very nearly the same size; peel one and weigh both. After 24 hours weigh again.
3. Which has lost the most in weight? Why?

EXERCISE 119

DIFFERENT FORMS OF APPLES

TIME: FALL TERM

Object: To learn to classify apples according to form.

Material needed: Apples of various forms.

DIRECTIONS

Study well the forms of apples as given in Fig. 57. Practice drawing these forms until you become

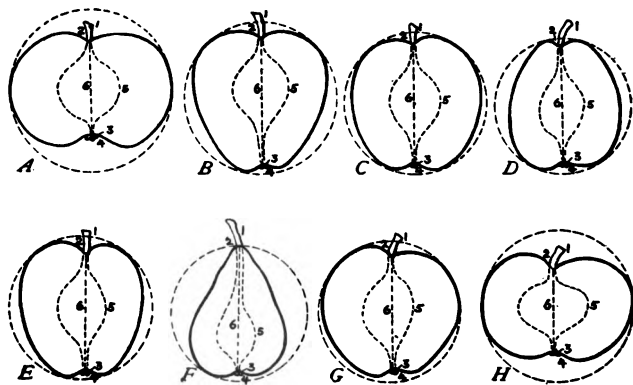


FIG. 49—FORMS OF APPLES

A, oblate; *B*, conical; *C*, ovate; *D*, obovate; *E*, oblong; *F*, acute; *G*, round-ovate; *H*, oblate-conical. 1, stem or stalk; 2, cavity; 3, calyx; 4, basin; 5, core; 6, axis.

familiar with them. Make a collection of different varieties of apples; let the class learn all the

varieties collected, and classify according to the following table:

Name of Variety	Form



EXERCISE 120

JUDGING APPLES

TIME: FALL TERM

Object: To learn how to judge apples by use of the score card.

Material needed: Apples, pencil, score card.

DIRECTIONS

Let four or more students each bring a plate of apples from the home orchard; set before the class and let each student score the number of points for each entry and compare with the teacher's score.

SCORE CARD FOR JUDGING APPLES

Owner of Exhibit Date.....

Points Noted	Maximum Score	Teacher's Score	Student's Score	Remarks
Size of exhibit.....	20			
Size of fruit.....	15			
Color.....	15			
Form.....	15			
Quality	15			
Freedom from blemishes.	20			
Total.....	100			

Name of Judge.....

When single plates are judged, the first score may be omitted.

EXERCISE 121

THINNING FRUIT

TIME: WHEN APPLES AND PEARS ARE ABOUT THE SIZE OF A SMALL CRAB; PEACHES AND PLUMS AFTER THE "JUNE DROP" IS OVER, AND DANGER FROM THE DEPREDAATION OF THE CURCULIO IS PAST

Object: To determine whether it pays to thin fruit.

Material needed: Heavily loaded apple tree in home orchard.

DIRECTIONS

In the home orchard select a tree heavily loaded with fruit. On either the east or the west side thin the fruit on one half of the tree, and leave the other half unthinned. Apples, pears, and peaches should be thinned to 6 or 8 inches; plums to 2 or 3 inches apart. When the fruit is ripe, compare the treated and untreated parts of the tree with reference to: total amount of fruit, number of broken limbs, color and size of fruit, and freeness from disease.

SUMMARY OF BENEFITS DERIVED FROM THINNING FRUIT

1. Lessens the production of seed, thus preserving the vitality of the tree.
2. Causes the tree to bear crops more regularly. Few fruit trees can produce large crops and bear fruit buds at the same time.

3. Will produce larger fruit.
4. Will produce better colored fruit by letting more sunlight into the tree.
5. Preserves the shape of the tree by preventing the breaking of overloaded branches, and lessens the loss occasioned by rot and other fungous diseases by eliminating the danger of infection by contact.

EXERCISE 122

PROPAGATION OF RED AND BLACK RASPBERRIES

TIME: FALL TERM

Object: To show that the red and the black raspberry are unlike in their methods of propagation, and that the red spreads more rapidly than the black.

Material needed: Red and black raspberry plants.

DIRECTIONS

Go to a garden or field in which both varieties are grown. You will notice that the canes of the black raspberries bend over and the tips take root in the ground. This is tip-rooting, or what some botanists call a stolon. If these are difficult to find, let some of the pupils cover the tips of some canes with soil and let them take root.

Notice that the red raspberry, instead of producing tip roots, sends up canes at intervals from roots under the ground. In this way a single plant in a few seasons will cover a considerable space of ground. If left undisturbed, the red raspberry will spend most of its time in producing new plants instead of fruit, but this can be prevented by cutting off all the new shoots except two or three for the next year's growth.

Are there any varieties growing in the neighborhood that differ in any way from the ones mentioned? If so, explain how you think they have been produced.

EXERCISE 123

GRAFTING WAX

TIME: EARLY SPRING

Object: To learn how to make grafting wax.

Material needed: Scales, tallow, beeswax, resin.

DIRECTIONS

Weigh out the following ingredients:

Tallow, 1 part.

Beeswax, 2 parts.

Resin, 4 parts.

Melt the tallow and beeswax, add the finely broken resin, and stir till a uniform mixture results. Then pour into cold water, but before the stuff hardens pull it like taffy. The hands must be well greased to prevent sticking. When a good "grain," as in pulled taffy, has been produced and when the wax becomes tough, mold it into balls or sticks for use.

EXERCISE 124

CLEFT GRAFTING

TIME: BEFORE BUDS BEGIN TO SWELL IN THE SPRING

Object: To change the variety by top-grafting.

Material needed: Apple tree, grafting knife, grafting wax.

DIRECTIONS

1. Select a branch 1 or 1½ inches in diameter and saw off the branch, using care so the bark may not be loosened from any part of the stub. Split the end of the stub with a broad, thin chisel or grafting tool.



FIG. 50—GRAFTING TOOL

2. Prepare the scion, or part to be inserted, by taking cuttings from the variety you desire to propagate, using the previous year's growth. Let the scions be long enough to contain two or three buds. Now cut the lower end of the scion wedge-shaped, leaving the outer edge thicker than the other.

3. Insert the scions in the cleft of the stock, being sure that the cambium layer or growing portion of stock and of the scion come in contact. To insure proper connection of the growing tissues set the scion at a slight angle with the stock. It is a good plan to cut the scion so the lower bud will come just at the top of the stub.

4. When the scions have been placed, cover all the cut portions with grafting wax.

Facts.—This method is popularly employed upon

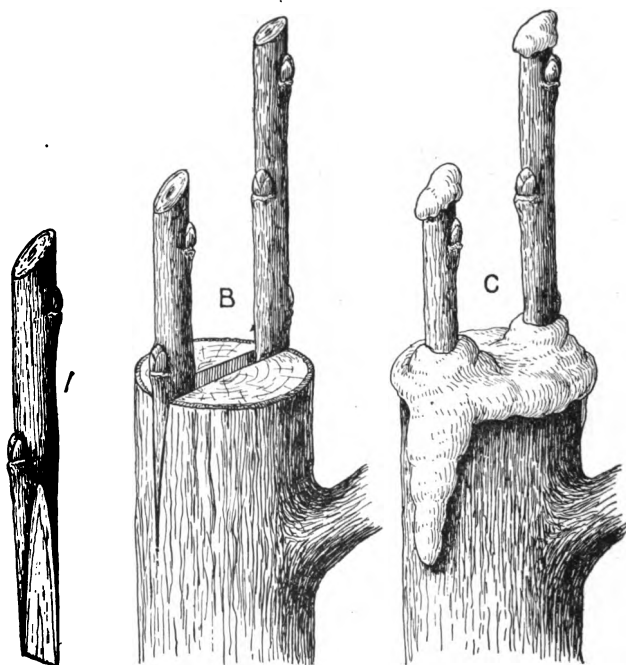


FIG. 51—CLEFT GRAFTING

A, prepared scion ; B, scions in place ; C, graft waxed over.

old trees of apple and pear, and is the most feasible way of top-working an old tree to a new variety. Not more than one-third of the tree should be so treated in any one year, because of the tendency to produce water sprouts when much wood is cut off.

EXERCISE 125

WHIP GRAFTING

TIME: DURING THE WINTER MONTHS

Object: To show how to produce new apple trees by means of whip grafting.

Material needed: Knife, apple roots, apple scions, grafting twine.

DIRECTIONS

1. This method of grafting is done by grafting scions on roots and can be done indoors. With a sharp knife make a diagonal cut at one end of the stock, as shown in Fig. 52, *a*. Let the cut surface be about 1 inch long. Next place the knife about one-third the distance from the end of the cut surface and split the stock in the direction of the longer axis. This split should be a little over $\frac{1}{2}$ inch long.

2. Prepare the lower end of the scion in like manner (Fig. 52, *b*). A small difference in the diameter of stock and scion may be disregarded.

3. Force the two parts together as shown in Fig. 52, *c*. If the cut surface on both stock and scion is straight the two parts will fit neatly. The cambium layer must come in contact on one side at least.

4. Wrap the united stock and scion with five or six turns of waxed yarn, prepared by soaking a ball of loosely wound yarn in melted grafting wax.

Facts.—Sometimes the entire root is used in this method, but usually the roots are cut into pieces from 4 to 6 inches long. Roots are dug and scions

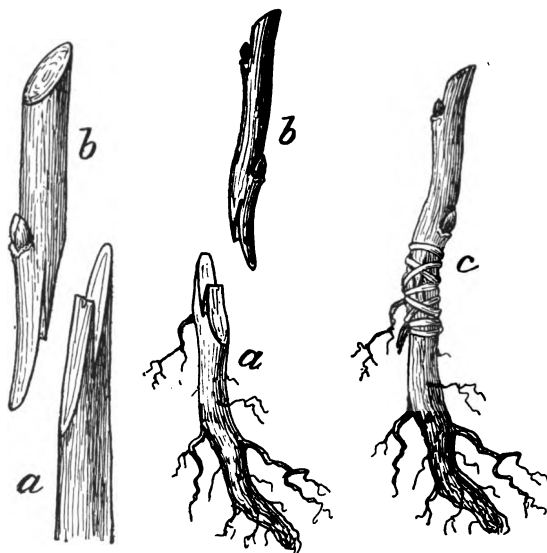


FIG. 52—WHIP GRAFTS
a, stock; *b*, scion; *c*, completed graft.

The drawing at the left shows two stems about to be united; those at the middle and right the grafting of a stem on a root.

cut in autumn and stored. When the operation is complete, the grafted stock is labeled and stored in moss, sawdust, or sand in a cool cellar until spring, when it is set in the ground deep enough to bring the union of stock and scion below the surface of the ground.

This method is very popular in Northern nurseries

for propagating young apple and pear trees, the former upon roots of seedling apples, grown for the purpose in Missouri and other Western states, and the latter upon pear seedlings mostly imported from France.

EXERCISE 126

BUDDING

TIME: JUNE TO EARLY SEPTEMBER

Object: To show how budding is done.

Material needed: Young peach trees, knife, raffia or yarn.

DIRECTIONS

1. To learn how to bud, practice on stems from $\frac{3}{8}$ to $\frac{1}{2}$ inch in diameter. Make a T-shaped cut through the bark, as shown in Fig. 53, C. Let the perpendicular slit be about $1\frac{1}{2}$ inches long and the horizontal slit only about $\frac{1}{2}$ inch.

2. From a branch of the same season's growth and of a known variety remove a strong, healthy bud (Fig. 53, A). Start the knife $\frac{1}{2}$ inch below the bud and cut upward under this bud, coming out about the same distance above it. Cut only deep enough into the wood so as not to injure the bud. Avoid too much wood under the bud.

3. Now place the bud, B, in the slit already made and push downward, until the bud is securely in place, as shown in D, Fig. 53.

4. The bud should now be tied, as shown at E, until a union is formed. Tie tightly with bands of raffia or yarn. As soon as the buds have united with the stock the material used in tying should be cut to prevent girdling the stock.

Facts.—Peaches are usually grafted in June, in the second year's growth; sometimes in the present year's growth, if done late in the season. The buds

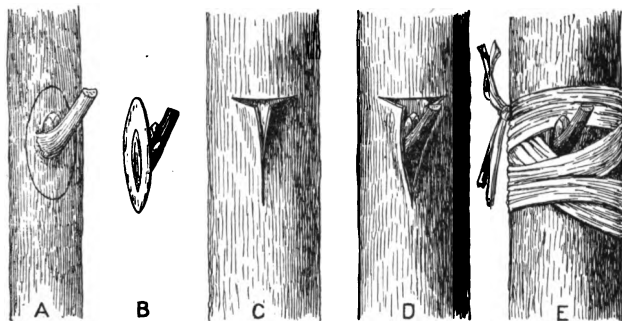


FIG. 53—COMMON BUDDING

A, method of cutting the bud; B, bud cut; C, method of preparing the stock; D, bud inserted; E, bud tied in place.

are placed near the ground in stocks, about the size of a chalk crayon. All the trees in which the buds have "taken" must have the tops cut off the following spring. A slanting cut is made just above the inserted bud.

EXERCISE 127

HARD-WOOD CUTTINGS

TIME: FALL TERM

Object: To show the method of propagating the grape and currant.

Material needed: Knife, young canes of grape.

DIRECTIONS

1. **Simple cuttings.**—Cut off a portion of the cane of a grape vine, so as to have two or more buds. As roots develop most readily near the joints, let the lower end be cut just below a bud. At the top the cut should be made some distance from the highest bud.

2. **Heel cuttings.**—Cut off a branch by cutting deep enough so as to remove a part of the parent branch. This severed portion of the parent branch is the so-called heel. Heel cuttings are more likely to develop roots than simple cuttings are, but only one cutting can be made from each lateral branch.

3. **Mallet cuttings.**—Sever a lateral branch with a portion of the parent branch, thus leaving a section of the parent branch on the base of the cutting. This method has the same advantage and disadvantage as the heel cutting.

4. **Single-eye cuttings.**—Cut the lateral branches into pieces having only one bud. This method is

used when it is desirable to make a large number of cuttings with a limited supply of material. Single-eye cuttings are commonly started under glass with

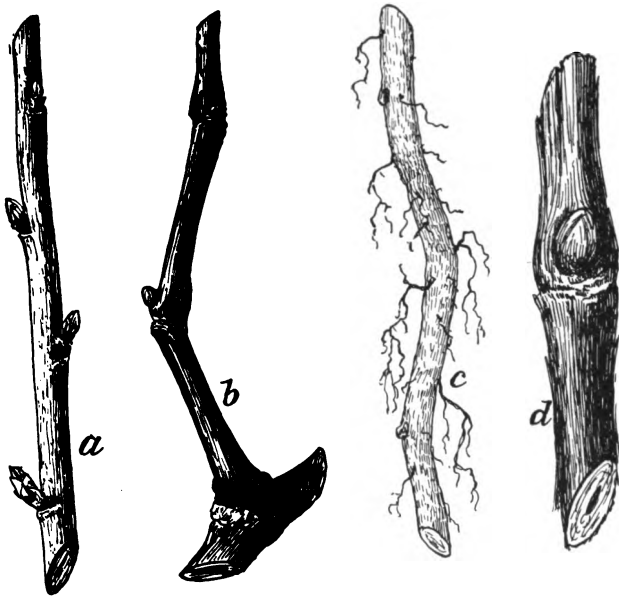


FIG. 54—CUTTINGS

a, simple cutting of currant; *b*, mallet cutting of grape; *c*, root cutting of blackberry; *d*, single-eye grape cutting.

bottom heat: sometimes in hotbeds. The bud is placed about 1 inch under the surface of the soil and kept moist. The cutting may be set either perpendicularly or horizontally with the bud up.

Cuttings may be kept over winter in a cool cellar, buried in sand, sawdust, or moss.

EXERCISE 128

TRANSPLANTING TREES

TIME: FALL OR SPRING TERM

Object: To learn how to prepare and transplant trees properly.

Material needed: Spade, knife, saw.

DIRECTIONS

The first work should be done in the presence of the whole class. It should be divided as follows: Digging up the tree, pruning, digging the hole, and setting the tree out. Let one student each be assigned to the divisions of work mentioned above. When the first tree has been planted, read the following rules for transplanting, and let the class judge as to whether any of the rules have been violated.

RULES FOR TRANSPLANTING*

1. Trees and shrubs that drop their leaves in autumn should be transplanted only while their leaves are off.
2. Take up the plant with the least possible harm to the roots.
3. Trim off broken and mangled roots with a sharp knife before replanting.
4. Cut off some of the branches before replanting.

*From Goff and Mayne's *Agriculture*.

5. Make the hole large enough to receive the roots easily.

6. Dip the roots in water before replanting.

7. Pack the moist soil closely about the roots.

8. If the soil is rather dry, add a pailful of water after putting the soil about the roots and before putting in all the dirt. If there are sods, put them on grass side down.

9. Mulch the soil about the trees or shrub, if the climate is subject to drouth in the spring.

EXERCISE 129

PRUNING

TIME: APRIL AND MAY

Object: To show where to cut off a branch in pruning a tree.

Material needed: Orchard.

DIRECTIONS

1. Study the manner of healing over of wounds made by pruning a tree. Describe the kind of wound which seems to heal most readily. From observations do you think it better to remove the branch by making the cut near the main stem or a little way from it?

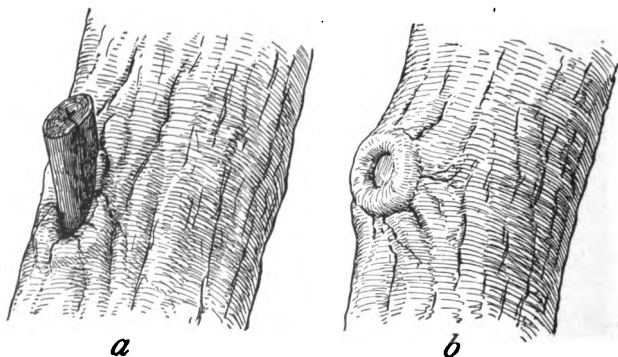


FIG. 55—RESULTS OF (a) INCORRECT PRUNING; (b) CORRECT PRUNING

2. Observe whether the branches have been removed with a saw or an axe. Which of the two implements would you use in pruning? Why?

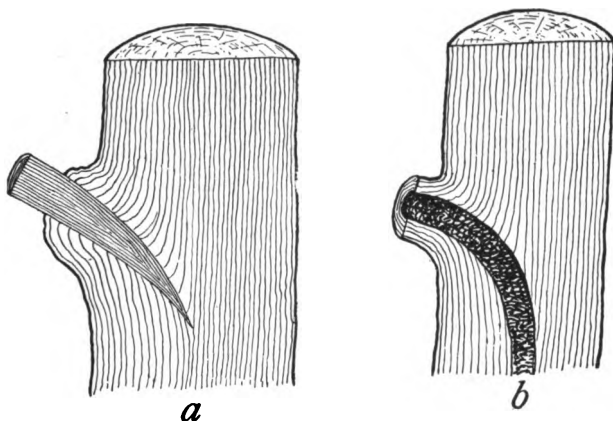


FIG. 56—DIAGRAM SHOWING RESULTS OF INCORRECT PRUNING

a, before stub decays ; *b*, after.

QUESTIONS

1. Suppose you wish to remove a large limb from a tree, how can it be done without splitting down as it falls?
2. Why is pruning usually done early in the spring?
3. Why should large wounds be painted over with white lead?

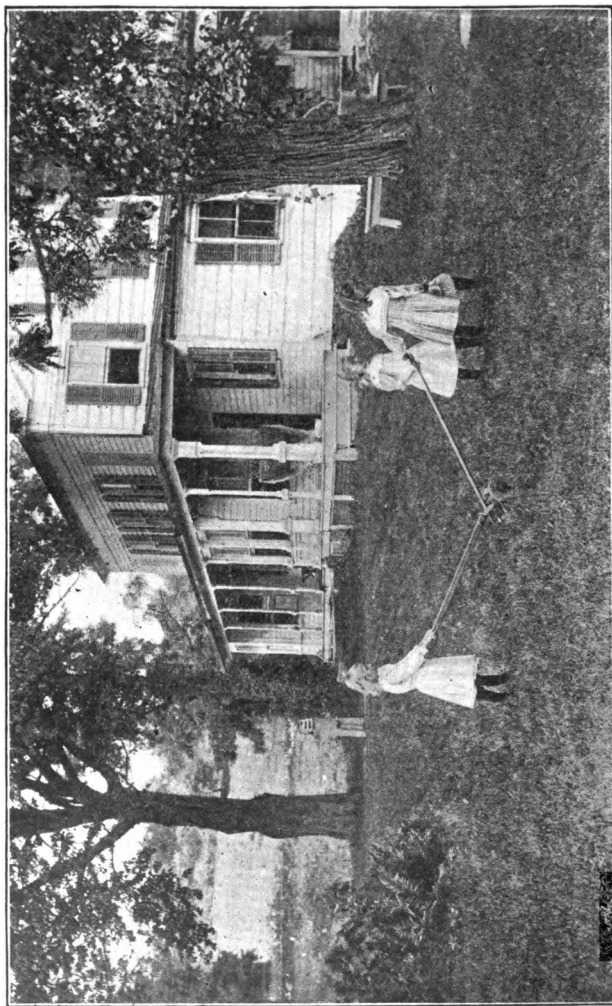


Photo by Prof. W. G. Johnson

• FIG. 57—COUNTRY HOME

"In the country the days have broad spaces, and the very stillness seems to give a delightful roominess to the hours."—*George Eliot*.

EXERCISE 130

MAP OF THE HOME GROUNDS

TIME: WHENEVER CONVENIENT

Object: To make a map of the home grounds, and find in whose home an effort is made to make the surroundings attractive.

Material needed: Paper and pencil.

NOTE.—Fig. 58 shows a school as it was before being improved; Fig. 59 shows improvements gained by planting shrubs and removing fences; and Fig. 60 shows a ground plan of

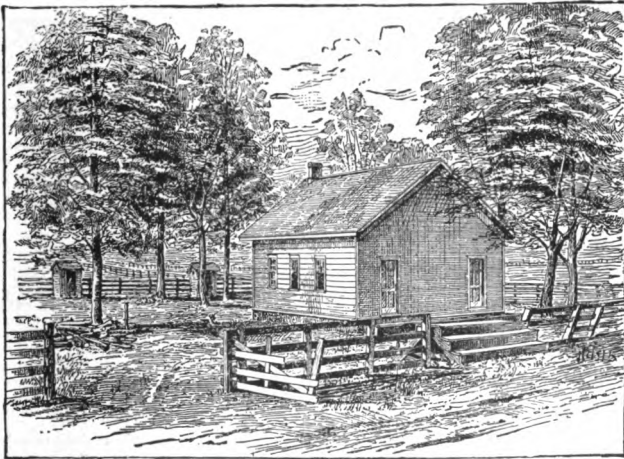


FIG. 58—SCHOOL GROUNDS BEFORE IMPROVEMENT

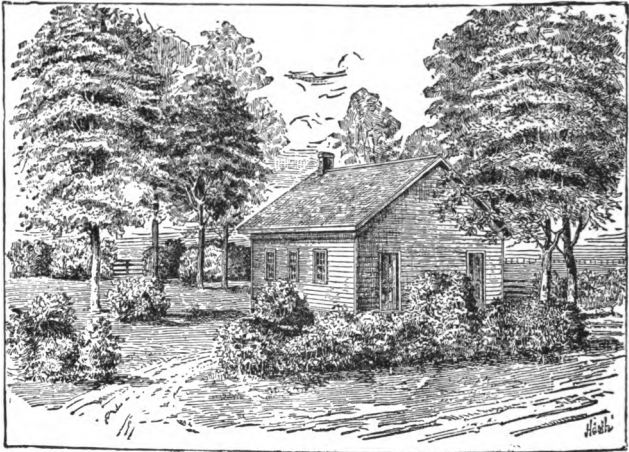


FIG. 59—SCHOOL GROUNDS AFTER IMPROVEMENT

the place after planting. This last will serve as a model for making a similar map of the home grounds.

DIRECTIONS

1. Use Fig. 60 as a model and draw a map of your home. Locate all the buildings, fences, paths, trees, flower beds, etc.
2. After having drawn the map, write a complete description and attach it.
3. Make a list of all the trees, shrubs, and flowers in the home grounds. Ask other members of the family to assist, if you have any difficulty in naming them.

QUESTIONS

1. Should boys assist in beautifying the grounds at home?

2. Why do you usually see prettier grounds in the city than in the country?
3. Is there a good lawn at your home?
4. What kind of grass makes the best lawn?

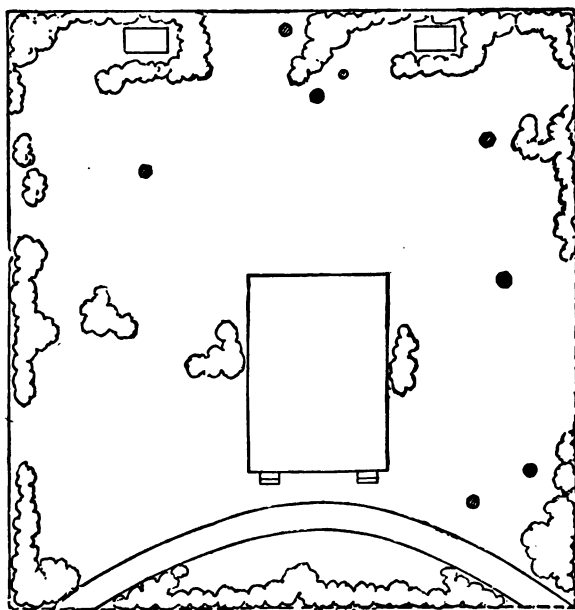


FIG. 60—PLAN OF IMPROVED SCHOOL GROUNDS

EXERCISE 131

ORDERS OF INSECTS

TIME: FALL TERM

Object: To become familiar with the different orders of insects.

Material needed: Note-book and pencil.

NOTE.—Insects are distinguished from other animals by the three parts of the body: head, thorax, and abdomen; three pairs of jointed legs, and generally two pairs of wings. A few are wingless.

Mature insects have a more or less hardened skin, to which the muscles are attached. The eyes are compound, being composed of a very large number of hexagonal corneæ, from 50 in the ant to many thousand in the winged insects. The mouths are adapted for either sucking or biting. There are four metamorphoses, or periods of growth: egg, larvæ, pupa, and adult. When all four are passed through by an insect the metamorphoses are said to be complete; if only three, incomplete. Growth takes place only during the larval period. The length of life of an adult ranges from a few hours to several years. The larvæ are hatched from eggs or, in a few cases, born alive. There are more than 250,000 species, grouped in orders, of which the following are the principal:

Order 1. *Orthoptera*.—Wings, four, front pair slightly thickened, hind pair transparent, broad and folded; hind legs usually large and fitted for leaping; land insects, biting mouths. Examples: Crickets, locusts, and grasshoppers.

Order 2. *Neuroptera*.—Bodies long and slender; wings,

four, large, transparent; mouths adapted for biting. Examples: Dragon flies, May flies, and caddis flies.



FIG. 61

INSIDIOUS FLOWER-BUG

Order 3. *Hemiptera*, or true bugs.—Mouths adapted to sucking; body flat; legs slender; wings, four, but sometimes wanting; some feed on juices of animals, others on juices of plants. Examples: Bedbug, louse, water strider, seventeen-year locust, and plant louse (*aphis*).

Order 4. *Diptera*, or flies.—One available pair of wings, some species wingless; eyes large; mouth of some, as the fly, enabled to lick up its food, of others, like the mosquito, fitted for piercing; legs slender; larvæ, footless grubs. Examples: Mosquito, Hessian fly, daddy longlegs, flea, house fly, and bot fly.

Order 5. *Lepidoptera*, or butterflies and moths.—Wings, four, large, covered with minute, overlapping scales; head small; body cylindrical; legs of little use for locomotion;

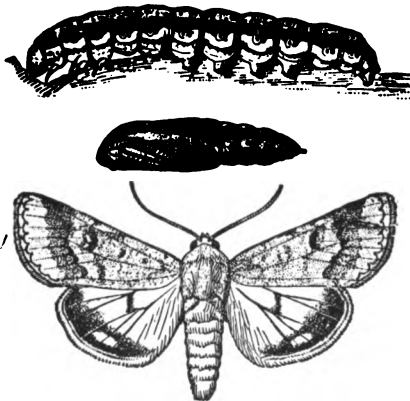


FIG. 62—A CUTWORM, PUPA AND MOTH

mouth fashioned into a long proboscis; larvæ called caterpillars or worms; butterflies fly during the day, moths at

night; wings of butterflies raised vertically when at rest, moths horizontally.

Order 6. *Coleoptera*, or beetles.—Recognized by the thickened, horny fore wings; strong legs make some of them powerful runners; larvæ wormlike, pupa motionless; mandibles well developed; biters. Examples: June bug, ground beetles, click beetles, and grain weevils.



FIG. 63—BALD-FACED HORNET

Order 7. *Hymenoptera*.—Except the silkworm, the most useful of the insects. Mouth fitted for biting and lopping; four transparent wings; females of many species provided with stingers; larvæ, footless, helpless grubs. Examples: Bees, ichneumon flies, and gall flies.

DIRECTIONS

Make a list of insects not mentioned above, and classify them according to the order in which they belong.

QUESTIONS

1. What insects are most injurious to farm crops?
2. Which usually do the greatest damage, sucking or biting insects?
3. How do you distinguish a moth from a butterfly; a beetle from a bug?
4. Is the caterpillar a worm?

EXERCISE 132

PREPARATION FOR COLLECTING INSECTS

TIME: FALL TERM

Object: To learn how to construct an insect net and prepare cyanide bottle.

Material needed: Wooden handle four feet long, two and one-half feet of No. 8 wire, piece of small broom wire, one yard of mosquito netting, needle and thread, wide-mouthed bottle (one-half pint), one-half ounce of potassium cyanide, poison label, handful of plaster of Paris.

DIRECTIONS

1. Insect Net. Bend the heavy wire in a circle and cross the ends, bending them parallel. Let

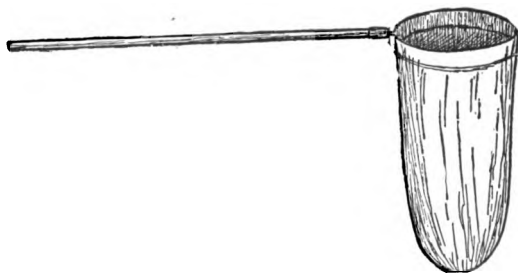


FIG. 64—INSECT NET

these parallel parts be 6 inches long. Cut a groove in the end of the handle on opposite sides and ex-

tending 8 inches from the end. Place the cross ends of the wire in the grooves and wrap them securely with the small wire. Make a bag of the netting, 30 inches long, with the diameter the same as the wire circle. Sew the bag to the wire circle.

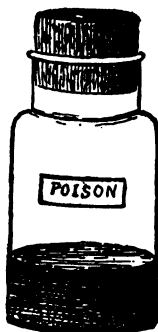


FIG. 65
KILLING BOTTLE

2. Cyanide Bottle. Break the cyanide* into small pieces, avoid its poisonous fumes, and place in the bottom of a wide-mouthed bottle. Pour over the pieces just enough water to cover them. Add plaster of Paris to absorb all the water. Leave the bottle unstoppered until the material within is dry, then cork it tightly. Affix the poison label and keep the bottle out of the way of children. If preferred, the cyanide can be covered with sawdust pressed down firmly and covered with a double thickness of blotting paper.

*Bear in mind that potassium cyanide is one of the most deadly poisons known. It looks like lump sugar and must be handled with great care. A piece the size of a pin's head in one's mouth would cause death.

EXERCISE 133

COLLECTION AND PRESERVATION OF INSECTS

TIME: FALL TERM

Object: To collect insects and preserve them.

Material needed: *Insect net, bottle, insect box, labels.*

DIRECTIONS

1. Go into the field and collect as many kinds of insects as you can find. Make notes on everything you may notice in connection with the life of the insects, their haunts, associates, food, shelter, natural enemies, etc. Observe the following rules in collecting:

1. Avoid noise and haste; wear quiet colors and keep your eyes open.

2. Do not allow insects to die a lingering death. Keep live specimens supplied with food, water, and fresh air.

3. Avoid the wanton destruction of life by collecting no more specimens than will be used.

2. After returning from collecting, remove the insects from the bottle and mount them. A cigar box will answer for this purpose. The bottom should be covered with cork, corrugated paper such as is used for packing,

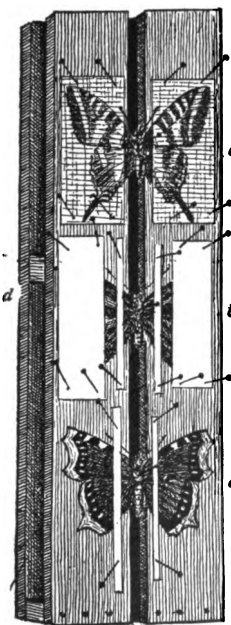


FIG. 66
SPREADING BOARD

or even sections of dry corn-stalks. Run a pin through the thorax of most insects and mount as shown in Fig. 67. In mounting beetles let the pin pass through the right wing cover near its upper end, and in mounting true bugs have it pass through the triangular-shaped plate near the

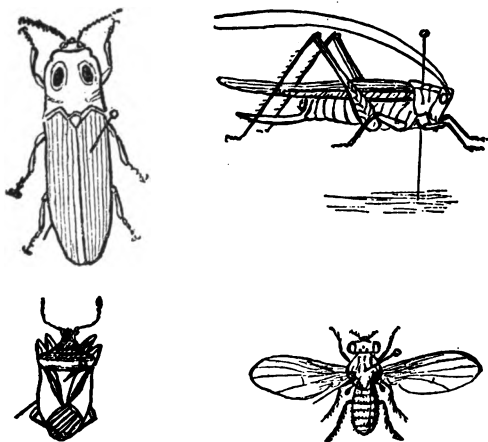


FIG. 67—CORRECT METHODS OF PINNING VARIOUS INSECTS

center of the back. Butterflies and moths should be kept on a spreading board a short time or until thoroughly dry. The spreading board consists of two thin pieces of boards placed almost together, leaving a groove just large enough to receive the body of the butterfly. Press down wings and fasten the wings with narrow strips of paper, as seen in Fig. 66.

EXERCISE 134

THE GRASSHOPPER (ORDER *Orthoptera*)

TIME: SUMMER OR FALL

Object: To study the form and habits of the grasshopper.

Material needed: Grasshoppers, living and dead, notebook.

DIRECTIONS

1. Make the following observations in the field:
 1. Its hours of activity.
 2. Its several methods of locomotion.
 3. Its protective coloring.
 4. Its natural enemies.
 5. The sounds (stridulation) made by the male while on the wing.
2. Find in a live specimen the large spiracle (breathing pore) just above the base of one of the middle legs. Watch the opening and closing of the two lips that guard the opening into the spiracle. Place some fresh leaves of corn or grass under a tumbler and watch the grasshopper's mode of eating. Liberate a large grasshopper in a room and note its longest leaps. How many times its own length? Make drawing of the whole insect.

3. Study the wings. Note how they are folded. Compare the form, color, size, texture, position, and use of the two wings.



FIG. 68—GREEN STRIPED LOCUST

The dry horny forewings are used in making the peculiar sound called stridulation. Draw the two

wings, showing system of veining.

4. How does the third pair of legs compare in shape, size, color, and use with the first and second pairs? Observe the hooks and double row of spines on the lower parts of one of the large legs. Of what advantage are these to the insect? Make an enlarged drawing of one of the hind legs.

5. The female may be distinguished from the male by the ovipositor. Find this at the end of the abdomen. It consists of four points and is used for making an opening in the ground to receive the eggs. Young grasshoppers are called nymphs, and they are very much like the parent in shape and appearance. What differences do you note between a nymph and an adult? Catch and feed some young grasshoppers for a month and make notes of what changes occur as the nymphs grow.

6. Compare the grasshopper with crickets, katydids, and cockroaches and note their points of resemblance and difference.

EXERCISE 135

THE DRAGON-FLY (ORDER *Neuroptera*)

TIME: SUMMER OR EARLY FALL

Object: To study the form and habits of the dragon-fly.

Material needed: *Insect net, cyanide bottle, note-book.*

DIRECTIONS

1. Collect several dragon-flies and keep some of them alive. While collecting, observe:

1. The places frequented.
2. The habit of flight.
3. The hours of flight.
4. The food sought.

2. Liberate a live dragon-fly in a closed room and note its mode of flight, the position of its wings in

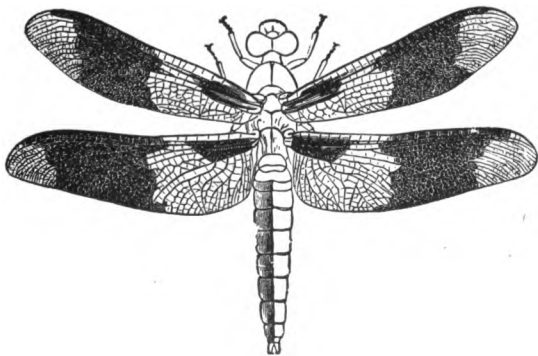


FIG. 69—A' DRAGON-FLY

flight and at rest. Place it in a cyanide bottle only long enough to stupefy it, then turn it out again upon a paper, and study its respiratory movements. The spiracles or breathing pores are on each segment of the abdomen. Two larger spiracles are found on each side of the thorax. Observe that the body is spindle-shaped, the head is rounded, and the abdomen angled and tapering.

3. Note the shape and size of the legs. How do they compare with those of the grasshopper? What is the advantage to the animal in having all the legs bunched together? Draw a general outline of this insect. Make an enlarged drawing of a wing, so as to show the veining. Note the transparency of the wing.

4. Find some nymphs in a shallow pond frequented by the dragon-fly. The nymphs are the young dragon-flies. Compare all parts of the body with the full-grown fly. Look about the vegetation above the water for nymph skins.

QUESTIONS

1. How many species of dragon-flies have you seen?

2. Why do the adults often dart down and dip the tip of their abdomens in the water?

3. What obnoxious insect is destroyed by dragon-flies?

4. Do dragon-flies fly forward only?

EXERCISE 136

THE CICADA OR DOG-DAY HARVEST FLY

(ORDER *Hemiptera*)

TIME: SUMMER OR FALL

Object: To study the harvest fly.

Material needed: *Harvest fly, note-book.*

NOTE.—This insect is known by its shrill cry while resting upon the boughs of trees. Its color is black and green, powdered with white underneath the body. The young flies are seldom seen, but the exuviae, or cast-off skins, which it sheds in molting, are objects of common observation. Eggs are laid in slits made in the twigs of trees. There they hatch; the young drop to the ground, bury themselves, and feed upon the juices of the roots of plants. They require two years to complete their growth. The second summer after hatching, the nymph crawls upon a weed or tree trunk, a short distance above the ground, and there molts, or casts off the old skin. After the wings are dry it flies away.

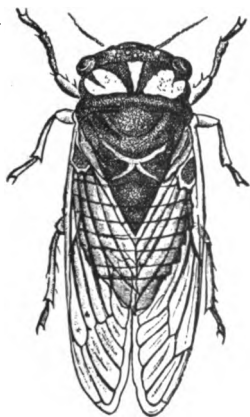


FIG. 70

DOG-DAY HARVEST FLY

DIRECTIONS

1. Study a full-grown specimen. Observe the general shape of the body. Note the peculiar mark-

ings on the body; the shape and position of the eyes. Observe the structure of the wings. Describe this. Draw a wing. How do the legs compare with those of the grasshopper?

2. Look at the base of the abdomen for the musical organs. These consist of ribbed parchment-like bags in little depressions. They are provided with powerful muscles by which the air is driven against the fluted surfaces. This vibration produces the noisy whirr so often heard.

EXERCISE 137

THE BLUEBOTTLE FLY (ORDER *Diptera*)

TIME: DURING WARM WEATHER

Object: To become familiar with the bluebottle fly.

Material needed: *Pieces of fresh meat, insect net, cyanide bottle.*

DIRECTIONS

1. Expose a bit of fresh meat until some of the bluebottle flies are attracted to it. Note the sound of their buzzing as they move around the meat. Do they seem to be shy? Catch a fly with the net; hold it by the feet, leaving its wings free. Is the buzzing in a lighter or lower key? Hold both wings and legs and note any difference in the pitch of the sound. How do you account for this variation?

2. Hold the piece of meat in the fingers, and with a hand lens study the fly's feeding habits. What is its manner of eating? Has it yet deposited any eggs on the meat?



FIG. 71

COMMON FLESH FLY

3. Leave a fly in the cyanide bottle until it is dead. Observe the general contour of the body. Compare the shape of the body with that of the other insects you have studied. Are the legs of the same shape and size? Note the number of segments in the ab-

domen. Study the shape, size, texture, and position of the wings. Make a drawing of one of the wings.

4. Place a bit of meat, upon which eggs have been laid, in a flower pot containing sand. Invert a tumbler over this, and press it into the sand to prevent the escape of offensive odors. The eggs will hatch in a few hours and the larvæ will soon begin to feed upon the flesh. Later they will crawl down into the sand and remain until they transform to the adult stage. If the weather is warm this will be speedily done, otherwise they may pass the winter before transforming.

EXERCISE 138

BEETLES (ORDER *Coleoptera*)

TIME: FALL OR SPRING TERM

Object: To study and compare different species of beetles.

Material needed: Insect net, cyanide bottle, note-book.

DIRECTIONS

1. Collect a number of beetles and name them. If you are unable to identify

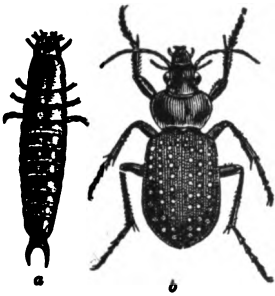


FIG. 72—GROUND BEETLE:

a, LARVA; *b*, ADULT

some of the beetles consult Comstock's *Insect Life*.

2. Study the different body parts as in the preceding exercises. What is the

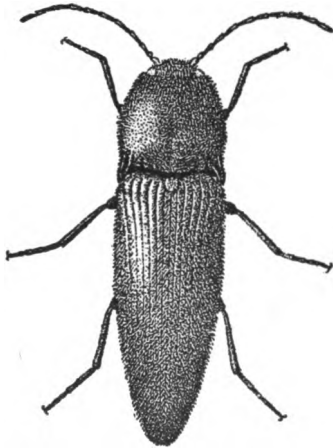


FIG. 73—A CLICK BEETLE

object of the hard wing coverings or elytra? Compare the mode of locomotion with that of the grasshopper. Upon what do the beetles feed?

3. Find out all you can in regard to the corn root worm, and prepare a short paper describing it.

QUESTIONS

1. How may you distinguish caterpillars from grubs?
2. Which are generally larger, beetles or bugs?
3. Are there any water beetles?

EXERCISE 139

BUMBLEBEES (ORDER *Hymenoptera*)

TIME: FALL TERM

Object: To study the form and life habits of the bumblebee.

Material needed: Same as in preceding exercise.

DIRECTIONS

1. Field study of the bumblebee. Observe:
 1. The kind of flowers upon which they feed.
 2. The flower most frequented by them, also what other insects feed upon the same flower.
 3. The two products gathered from flowers: nectar and pollen.
 4. Whether they visit more than one species of plants on the same trip.
 5. Whether they are shy while feeding.
 6. The time spent on each flower.
2. Wet a bee with water while feeding, and note the effect on the power of flight. Are bumblebees frequently caught in rains?
3. Collect several bees and put them in the bottle. Note the pitch of the humming while in the net. Compare a bumblebee with a butterfly in:
 1. Speed and directness of flight.
 2. Rapidity of wing strokes.
 3. Relative size of body and wings.

QUESTIONS

1. Why does not an early cutting of clover make good seed?
2. Why does the honey bee feed on white clover?
3. During what hours of the day are bumblebees most active?
4. Where do they build their nests?

EXERCISE 140

THE CABBAGE BUTTERFLY (ORDER *Lepidoptera*)

TIME: SPRING OR FALL

Object: To study the characteristics of the cabbage butterfly.

Material needed: Same as in preceding exercise.

NOTE.—This butterfly is small, with yellow wings bordered with black, and has a silvery spot on the lower surface of the hind wings.

DIRECTIONS

1. Collect specimens for use and for preservation. While collecting, study the butterfly's haunts and habits. Observe:



FIG. 74—CABBAGE BUTTERFLY

1. The kind of flowers on which they feed.

2. Whether they feed while on the wing, or while resting on the flower.

3. The food, which is nectar, the raw material of which honey is made, found at the base of the petals. Can you taste the nectar in the flower? What organ does the butterfly use in collecting the nectar?

2. Liberate a live butterfly on a closed window.

Note the position of its wings when at rest. This position is taken by all true butterflies and enables one to distinguish a butterfly from a moth. Observe the insect's irregular flight and peculiar jerky walk.

3. Make careful observation of all parts of the body and record what you see. Examine the scales under a lens.

4. Make a collection of a number of species of butterflies and note differences in shape, size, color, and habits.

EXERCISE 141

PREPARATION OF SPRAYING MATERIAL

TIME: JUST BEFORE TIME FOR SPRAYING

Object: To learn how to prepare Bordeaux mixture, Paris green, kerosene emulsion, and lime-sulphur wash.

DIRECTIONS

1. Bordeaux mixture:

Prepare the mixture as follows:

Copper sulphate (blue vitriol), 4 pounds.

Quicklime (not slaked), 4 pounds.

Water, 50 gallons.

Hang the copper sulphate in a burlap bag which dips a few inches below the surface of 25 gallons of the water in a barrel. In another barrel slake the lime with a little water and when done add the balance of the water; stir and strain. Pour the two solutions together either through hose or from two pails held near each other and poured from simultaneously so the two streams mix as they fall and continue to do so in the barrel. If Bordeaux is to be used on peach foliage, add 25 more gallons of water.

2. Paris green:

For apples and pears: 1 pound of Paris green, 2 pounds lime, 150 gallons of water.

For plum and cherry: 1 pound of Paris green, 2 pounds lime, 300 gallons of water.

For potato beetle: 1 pound Paris green, 60 gallons of water.

Paris green should not be used on peach foliage.

Mix the Paris green in a cup with a little water, until it is like paste. If added dry to the water it will float.

3. Kerosene emulsion: For kerosene emulsion use the following ingredients:

Kerosene (coal oil), 2 gallons.

Rain water, 1 gallon.

Soap, $\frac{1}{2}$ pound.

Dissolve the soap in boiling water; remove from the fire and while hot pour in the kerosene. Churn briskly for five minutes. Before using dilute with six to nine parts of water.

4. Lime-sulphur wash:

Lime, 15 pounds.

Sulphur, 15 pounds.

Water, 50 gallons.

Slake the lime with hot water, then add water till it makes a thin whitewash. Blend the sulphur with water into a thin paste; add to the whitewash and mix thoroughly. Boil one hour, or until the mixture is of a brick-red color, stirring frequently to keep it from caking on the side of the vessel. Dilute to 50 gallons and bring to a boil again; strain it boiling hot through a wire screen and apply as hot as possible.

EXERCISE 142

STUDY OF SPRAYING CALENDAR

TIME: WHENEVER CONVENIENT

Object: To learn how to combat insect pests and plant diseases.

DIRECTIONS

Study well the table given in this exercise, so that you may know when, how, and for what to spray.

Insect Pest or Disease	When to Spray	With What to Spray
All scale insects	Early spring before buds swell	Lime-sulphur wash
Striped melon beetle	When young plants appear above ground	Tobacco dust
All leaf-eating insects	When insects appear	Paris green, or other arsenical poison
Fruit rot	Before blossoms open	Bordeaux mixture
Codling moth	Just after the blossoms fall	Paris green
Leaf curl	Before buds swell	Bordeaux mixture
Twig blight*	Before buds open	Lime-sulphur wash
Potato scab	Treat before planting	2 per cent. solution of formalin
All sucking insects, as plant lice	When insects appear	Kerosene emulsion or miscible oils
Mildews and black rot of grape	Before blossoms open When leaves are one-third grown Just after fruit sets, and every two weeks thereafter	Bordeaux mixture

* Cut affected branches back to sound wood and burn them. Keep tools disinfected by wiping with cloth saturated with kerosene.

EXERCISE 143

PREPARATION OF HERBARIUM SPECIMENS

TIME: SPRING TERM

Object: To learn how to prepare plants for the herbarium.

Material needed: Newspapers, carpet paper, scissors, note-book.

DIRECTIONS

1. In preparing herbarium specimens, use driers made of ordinary carpet paper, cut into sheets 12 by 18 inches. Place each plant in a folder made of newspaper, and alternate with the driers.

2. Place upon the pack a plank of the same size as the driers, and subject the whole to a pressure of 50 to 100 pounds by means of blocks of wood, or stones.

3. The driers must be replaced by dry ones daily during the first four or five days, and after that at longer intervals for a week or ten days, until the specimens are dry. In changing the driers simply shift the folders containing the plants from one set of driers to dry ones.

4. When the specimens are dry, fasten them to stiff white paper by means of strips of gummed paper. Place a label bearing the name, place, date of collecting, and collector's name in the lower right-hand corner.

5. Collect all the different weeds of the farm, dry, mount, label, and keep for future reference.

GLOSSARY

- Absorption**—The process of taking in substances, as a sponge drinking in water.
- Acid**—A chemical compound sour to the taste, capable of turning blue litmus paper red.
- Alkaline**—Alkaline substances are not sour, have a soapy taste, and turn reddened litmus paper blue.
- Ammonia**—A chemical combination of hydrogen and nitrogen.
- Ash**—The material left after the burning of organic substances.
- Assimilate**—To convert into the tissues of the plant or of the animal.
- Bacteria**—Minute plants frequently present in fermentation, decay, and disease. They thrive in the nodules found on the roots of clover, alfalfa, cow-peas, etc.
- Balanced ration**—A feed containing the proper proportion of protein and carbohydrates.
- Barren**—Not fruitful.
- Calcium carbonate**—Limestone; a combination of carbonic acid gas and calcium.
- Calyx**—A whorl of green leaves at the base of the flower.
- Capillary**—Applied to very minute tubes or pore spaces through which liquids may move.
- Carbohydrates**—Foods which include starch, the sugars, and cellulose. They are composed of carbon, hydrogen, and oxygen.
- Carbon dioxide**—Sometimes called carbonic acid gas; composed of oxygen and carbon.
- Cereals**—Crops which are grown for their grain.
- Chemical change**—A change in which a new substance is formed.
- Clay**—The finest of soil particles; a combination of silica, alumina, and water.
- Combustion**—The act of burning.
- Condensation**—The process of changing gases or vapors to the liquid state.

- Copper sulphate**—Bluestone; a combination of copper and sulphuric acid.
- Corolla**—A whorl of leaves just inside the calyx and usually colored other than green.
- Cryptogam**—A low class of flowerless plants; example, mushrooms.
- Curculio**—A snouted beetle, very injurious to the plum and apricot.
- Cuttings**—Parts of the stem, root, or leaf used for producing a new plant.
- De Candolle**—A French botanist.
- Decomposition**—The act of breaking up a compound into its elements.
- Deliquescent**—Branched in a manner so that the stem or trunk is lost in the branches.
- Detasseling**—Removing the tassels.
- Disseminate**—To scatter, as seed; to spread.
- Dormant**—Not active; asleep.
- Effervescence**—The production of innumerable small gas bubbles in a liquid by chemical activity.
- Evaporation**—The changing from a liquid to a gaseous state.
- Excurrent**—The term used when an axis continues throughout the body. Example, the trunk of a pine.
- Experiment**—A trial, proof, or test of anything.
- Fertility**—Fruitfulness, richness, power to produce.
- Fertilizer**—Any material that will enrich the soil and supply plant food.
- Fiber**—Short cells which make up the substance of solid wood.
- Fibrous**—Consisting of fibers. Example, the roots of the wheat plant.
- Florist**—One who cultivates flowering plants.
- Formaldehyde**—A chemical compound used for preventing decay.
- Function**—Office or action of organs in animal or vegetable life.
- Germinate**—To grow.
- Gluten**—A substance in grains containing albumen. It makes wheat dough tenacious and elastic.
- Graphic**—Written, drawn, inscribed.

Gravity—The force which tends to pull bodies to the center of the earth.

Heaves—A disease in horses characterized by heavy and laborious breathing.

Humus—Vegetable mold formed by the decay of plants.

Ingredient—One of the substances composing any compound or mixture.

Insoluble—Not readily dissolved.

Kainit—A potash fertilizer found in large quantities in Germany; contains about 25 per cent. sulphate of potash, mixed with sulphate of magnesia and common salt.

Kernel—That which is inclosed in a shell, husk, etc.

Lime—Combination of calcium and oxygen, formed by burning limestone.

Lime water—A solution made by dissolving lime in water.

Litmus paper—A paper used for determining whether substances are acid or alkaline.

Loam—Soil containing a mixture of sand and clay.

Membrane—A thin tissue that will permit the passage of a liquid through it.

Mulch—A layer of vegetable matter or dust on the soil used to check the loss of soil moisture by evaporation.

Nectar—A sweet juice found in flowers from which bees make honey.

Nitrate—Combination of nitric acid with a metal or salt. The form of nitrogen used by plants.

Nitrogen—An element of plant food used chiefly in making stems and leaves.

Nitrogen-free extract—Animal or vegetable compounds with no nitrogen in their composition.

Nitrogenous matter—Substances containing nitrogen.

Nutritive—Having the power of nourishing or building up the body.

Oblate—Flattened or shortened.

Oblong—Longer than broad.

Organic matter—The part that passes into the air in burning substances.

Osmosis—The mixing of dissimilar substances through a porous membrane.

Ovary—A hollow case at the base of the pistil containing the egg cell.

Pasteurizing—A process by which the fermentation of milk is retarded.

Petal—One of the divisions of the corolla.

Phosphoric acid—Compound composed of phosphorus and oxygen.

Pistil—Part of the flower that receives the pollen.

Potash—Composed of potassium and oxygen; one of the essentials of plant food.

Prolificacy—Fruitfulness, great productiveness.

Propagate—To generate, to increase, to renew.

Protein—An ingredient of foods used in building muscle.

Protoplasm—The living matter of a cell.

Rape—A plant of the turnip family.

Ration—A fixed amount or quantity of food.

Resin—A substance that exudes from plants when incisions are made in the stems or branches.

Respiration—The act of breathing.

Rigidity—The state of being rigid.

Saturate—To fill fully, to soak.

Sediment—The matter which settles to the bottom from water or any other liquid.

Sepal—One of the divisions of the calyx.

Silt—Very fine soil particles, just between fine sand and clay in size.

Solutions—Product formed by dissolving a gas or a solid in water.

Stamen—Parts of the flower which bear the pollen.

APPENDIX OF USEFUL TABLES

SCORE CARDS

COMPOSITION OF MANURES

TABLE I
NITROGENOUS MANURES

Article	Pounds in a Hundred		
	Nitrogen	Phosphoric Acid	Potash
Sodium nitrate.....	15½ to 16	.....	.....
Ammonium sulphate..	19 to 20½	.....	.....
Dried blood, high grade.....	12 to 14	.....	.....
Dried blood, low grade.....	10 to 11	3 to 5	.....
Concentrated tankage.....	11 to 12½	1 to 2	.....
Tankage, bone.....	5 to 6	11 to 14	.....
Dried fish scrap.....	7 to 9	6 to 8	.....
Cottonseed meal.....	6½ to 7½	1 to 2	2 to 3

TABLE II
PHOSPHATIC MANURES

Article	Pounds in a Hundred		
	Phosphoric Acid		
	Available	Insoluble	Total
South Carolina phosphate rock.....	.....	26 to 28	26 to 28
Florida phosphate rock.....	.....	33 to 35	33 to 35
South Carolina dissolved rock.....	12 to 15	1 to 3	13 to 16
Florida dissolved rock.....	14 to 16	1 to 4	16 to 20
Ground bone.....	5 to 8	15 to 17	20 to 25
Steamed bone.....	6 to 9	16 to 20	22 to 29
Dissolved bone.....	13 to 15	2 to 3	15 to 17

TABLE III
POTASSIC MANURES

Article	Pounds in a Hundred			
	Potash	Phosphoric Acid	Lime	Chlorine
Muriate of potash.....	50	.....	.....	40 to 48
Sulphate of potash.....	48 to 52	.....	.....	$\frac{1}{2}$ to $1\frac{1}{2}$
Kainit.....	12 to $12\frac{1}{2}$	.....	.....	30 to 32
Sylvanit.....	16 to 20	.....	.....	42 to 46
Cottonseed: hull ashes.....	20 to 30	7 to 9	10	.....
Wood ashes, unleached.....	2 to 8	1 to 2	30 to 35	.....
Wood ashes, leached.....	1 to 2	1 to $1\frac{1}{2}$	35 to 40	.....
Tobacco stems.....	5 to 8	3 to 5	$3\frac{1}{2}$	.....

TABLE IV
AVERAGE COMPOSITION OF FARM MANURES

Article	Pounds in a Hundred				
	Moisture	Nitrogen	Phosphoric Acid	Potash	Lime
Cow manure, fresh.....	85.3	0.38	0.16	0.36	0.31
Horse manure.....	71.3	0.53	0.28	0.53	0.21
Sheep manure.....	64.6	0.83	0.23	0.67	0.33
Hog manure.....	72.4	0.45	0.19	0.60	0.08
Hen manure	56.0	1.63	0.54	0.85	0.24
Mixed stable manure....	75.0	0.50	0.26	0.63	0.70

TABLE V—STOCK-FOODS
AVERAGE OF DIGESTIBLE NUTRIENTS AND FERTILIZER CONSTITUENTS IN STOCK-FOODS

Name of Food	Dry Matter in 100 Pounds	Digestible Nutrients in 100 Pounds			Fertilizer Constituents in 100 Pounds		
		Protein	Fat	Carbo- hydrates	Nitrogen	Phos. Acid	Potash
Green food and ensilage—							
Corn fodder.....	20.7	1.0	0.4	11.6	0.30	0.15	0.30
Sorghum fodder.....	30.6	0.7	1.2	17.1	0.30	0.09	0.85
Rye fodder.....	23.4	2.1	0.4	14.1	0.33	0.25	0.70
Kentucky blue grass.....	34.9	3.0	0.8	19.8	....	....	....
Red clover.....	29.2	2.9	0.7	14.8	0.54	0.15	0.40
Cow-pea vines.....	16.4	1.8	0.2	8.7	0.37	0.10	0.30
Corn ensilage.....	20.9	0.9	0.7	11.3	0.28	0.10	0.37
Hay and dry fodders—							
Corn stover.....	59.5	1.7	0.7	32.4	1.10	0.20	1.40
Timothy hay.....	86.8	2.8	1.4	43.4	1.00	0.50	1.41
Hay, mixed grasses.....	87.1	5.9	1.2	40.9	1.40	0.27	1.55
Red clover.....	84.7	7.6	2.0	38.4	2.00	0.38	2.20
Cow-pea vine hay.....	89.3	10.8	1.1	39.0	2.66	0.52	1.47
Oat straw.....	90.3	1.2	0.8	38.6	0.46	0.28	1.77
Wheat straw.....	90.4	0.4	0.4	36.3	0.60	0.22	0.63
Root crops—							
Turnips.....	9.5	1.0	0.2	6.1	0.19	0.09	0.34
Potatoes.....	31.6	1.2	....	24.1	0.24	0.08	0.37
Grain and other seed—							
Corn.....	89.1	8.0	4.6	65.9	1.58	0.57	0.37
Oats.....	80.0	9.2	4.2	47.3	1.65	0.60	0.48
Barley.....	80.1	8.7	1.6	65.6	1.51	0.79	0.48
Cow-peas.....	87.8	20.0	0.8	53.2	3.87	0.82	0.99
Cottonseed.....	90.1	13.2	16.9	29.1	3.10	1.05	1.09
Mill products—							
Corn meal.....	85.0	5.5	3.5	63.8	1.58	0.63	0.40
Corn and cob meal.....	84.9	4.4	2.9	60.0	1.41	0.57	0.47
Wheat bran.....	88.1	12.8	2.7	39.2	2.67	2.89	1.61
Wheat middlings.....	87.9	12.8	3.4	53.0	2.63	0.95	0.63
Cottonseed meal.....	91.5	38.1	12.6	16.0	6.90	3.00	1.50
Cottonseed hulls.....	89.5	0.3	1.7	32.9	0.69	0.25	1.02

TABLE VI

STANDARD FERTILIZER FORMULAS FOR CORN AND COTTON ON OLD UPLANDS, RECOMMENDED BY THE GEORGIA STATION*

FORMULA NO. 1

For Corn on Old, Worn Uplands

1. Acid phosphate (14 per cent.).....1,000 lbs.
2. Cotton meal ($2\frac{1}{2}$:7:1 $\frac{1}{2}$).....1,250 lbs.
3. Muriate of potash (50 per cent.)..... 30 lbs.
4. (or kainit, 120 lbs.)

Total.....2,280 lbs.

Analysis:

	Ph.	Ni.	Po.
Using 1, 2, 3.....	7.50	3.83	1.48
Using 1, 2, 4.....	7.21	3.70	1.43

FORMULA NO. 2

For Cotton on Old, Worn Uplands

1. Acid phosphate (14 per cent.).....1,000 lbs.
2. Cotton meal ($2\frac{1}{2}$:7:1 $\frac{1}{2}$)..... 700 lbs.
3. Muriate of potash (50 per cent.)..... 75 lbs.
4. (or kainit, 300 lbs.)

Total.....1,775 lbs.

Analysis:

	Ph.	Ni.	Po.
Using 1, 2, 3.....	8.87	2.70	2.70
Using 1, 2, 4.....	7.87	2.45	2.45

On well improved soils, or comparatively new lands, the cottonseed meal may be reduced by one-third to one-half in either of the foregoing formulas. On such soils, when only a very light application is intended to be made, acid phosphate alone may give more profitable results than a complete fertilizer.

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TABLE VII
AVERAGE COMPOSITION OF FARM MANURES

Farm Manures	Pounds in a Hundred			
	Nitrogen	Total Phos. Acid	Potash	Lime
Cow manure (fresh)	0.34	0.16	0.40	0.31
Horse manure (fresh)	0.58	0.28	0.53	0.21
Sheep manure (fresh)	0.83	0.23	0.67	0.33
Hog manure (fresh)	0.45	0.19	0.60	0.08
Hen manure (fresh)	1.63	1.54	0.85	0.24
Mixed stable manure	0.50	0.26	0.63	0.70

TABLE VIII
LEGAL WEIGHTS OF A BUSHEL OF PRODUCE

Articles	Pounds
Apples	48
Apples, dried	24
Beans	60
Buckwheat	52
Corn, ear	70
Corn, shelled	56
Onions	57
Peaches	38
Potatoes, Irish	60
Potatoes, Sweet	55
Peas	60
Bluegrass seed	14
Timothy	45
Cloverseed	60
Cottonseed	32
Wheat	60
Oats	32
Turnips	55
Barley	48
Rye	60

COTTON SCORE CARD (JOHNSON)

1. PLANT

Size, medium to large.....	6	.....	.....
Form, spreading conically.....	6	.....	.....
With jointed and developed branches	4	.....	.....
Properly shaped and filled head or center	4	.....	.....

2. PROLIFICACY

Number of bolls.....	10	.....	.....
Trueness, to variety type in arrange- ment of bolls, singly or in clusters..	5	.....	.....

3. BOLLS

Size, large.....	5	.....	.....
Form, true to type.....	5	.....	.....
Opening, good, fair, poor.....	5	.....	.....

4. TOTAL YIELD OF SEED COTTON..... 20

5. PER CENT. OF LINT TO SEED..... 20

6. LINT

Length	2.5	.....	.....
Fineness	2.5	.....	.....
Purity	2.5	.....	.....
Uniformity	2.5	.....	.....

Total.....100

Name of scorer.....

Date.....

Place.....

Sample No..... Rank.....

DIRECTIONS FOR JUDGING COTTON*

On the score card as suggested the ideal plant is given a rating of 20 points. In judging the exhibits in contests, cuts should be made more severe as the plant departs further from the standard.

* From Bulletin No. 44, University of Georgia.

1. THE PLANT

For plants departing only slightly from the variety standard as to size, a cut of one to two points should be made. If this departure is very marked, a cut of four points may be made. For less than three or more than four lower long branches cut one point for each unit of departure. If these branches are defective either in total length or in diameter of the stem, cut from one to three points as the departure may be more or less pronounced.

For excessively long joints and poorly placed and developed branches cut a maximum of three points. For slight defects in these respects cut from one-half to two points.

For a well opened or vase-shaped head admitting air and light in abundance, allow four points as the perfect score. When the head is full on account of superabundance of long upright branches, cut a maximum of three points; as these faults are less pronounced reduce the cuts until for slight defects on these accounts a maximum cut of one-half point should be given.

2. PROLIFICACY

In considering the fruitfulness of a plant or set of plants the term prolificacy can be used only in a relative sense. The plant possessing the greater number of bolls should be given a rating of ten, or perfect in this respect; while others should be cut more or less severely as the number of bolls they bear fall below that of the standard. The single or cluster arrangement of bolls should vary with the typical habit of the variety—some varieties are cluster-bearers, while others are noted for bearing bolls singly. Uniformity in which the bolls are arranged on any exhibit should be made the standard. Give an exhibit absolutely uniform in this respect five points. As others are more or less irregular in this respect cut from one to four points on the score card.

3. BOLLS

Next in importance to prolificacy or number of bolls is their size, shape, and manner of opening. Large bolls yield more cotton to the boll than do small ones. There is also a difference in the average size of the bolls on different plants of any single variety. The preference should be given to the plants bearing the larger bolls, provided, of course, the increase in size fully compensates for the decrease in number. Let the judge of any set of exhibits strike an average in size of the bolls on three of the largest balled stalks shown and use this as his standard.

Now, as plants are judged for size of bolls, where bolls are only slightly below the standard cut from one-half to one point. As this departure becomes more marked the cuts should be more severe, until the maximum cut of four points should be made for a plant whose bolls are less than one-half the standard size.

The shape or form should be true to that peculiar to the particular variety shown. Uniformity in shape or form in plants and fruit shows good breeding, and also suggests ability to transmit desirable qualities to the progeny. Consequently, it is of value to the plant breeder. Give the plant whose bolls are all of one form or shape consistent with that of the variety a rating of five points. As the bolls are of different shapes cut from one to four points as the number departing greatly from the variety shape increases.

The way in which the mature bolls open is of importance. The opening should be such as to make the cotton easy to pick, but at the same time it should not be such as to cause shedding of lint. For the best opening bolls give the plant a rating of five points. If the opening is only fair, make a cut of from one to two, and when it is poor cut from three to four points.

4. YIELD OF SEED COTTON

Yield of seed cotton while depending on the three qualities already discussed, that is, the right kind of plant and a sufficiently large number of bolls of good size and shape, should

have considerable weight in fixing the value or superior rating of any cotton exhibit.

After the exhibit has been rated as to prolificacy and size of bolls, select a fixed number, say ten average sized bolls, already opened, pick the seed cotton from these bolls, determine the yield from these bolls, and then with this average calculate the yield from the entire ten plants constituting the exhibit. Give the best-yielding lot a rating of 20 points. Then as others yield less and less give them a maximum of 15 points.

5. PER CENT. OF LINT

After the total yield has been rated attention must be given to the per cent. of lint produced by the different lots of cotton to be judged. This is given a possible rating of 20 points, which should be assigned only to samples showing not less than 35 per cent. of the lint to seed cotton. For each and every 1 per cent. below 35 the sample should be given a cut of one point. Thus if a sample should show only 25 per cent. lint, it should receive a cut of 10 points, which deducted from the possible score of 20 points, indicating perfection, leaves only 10 points to the credit of the sample.

The per cent. of lint should be determined by taking the contents of a few bolls from each sample, placing them in the sun or, better, a dry room for a period sufficiently long to bring the samples to a uniform point of dryness; after which the lint should be removed from the seed by hand, after which each should be carefully weighed and the percentages calculated.

6. QUALITY OF LINT

Quality of lint is assigned a possible rating of ten points on the score card. These are divided up as follows: Length, $2\frac{1}{2}$ points; fineness, $2\frac{1}{2}$; purity, $2\frac{1}{2}$; uniformity as to length, fineness, purity, and freedom from faulty fibers, $2\frac{1}{2}$ points. Of course, these scores are intended only to offer means or standards by which the different exhibits may be compared. Therefore, when there is a point about which there seems to be uncertainty, the most perfect sample can well be given the highest

OFFICIAL CORN SCORE CARD

(After Holden)

Name of scorer.....Date.....Place.....

Sample No.....Table.....

1. Trueness to type or breed characteristics..... 10	1	2	3	4	5	6	7	8	9	0
2. Shape of ear..... 10										
3. Purity of color— a. Grain..... 5										
b. Cob..... 5										
4. Vitality or seed condition 10										
5. Tips..... 5										
6. Butts..... 5										
7. Kernels, a. uniformity of 10										
b. Shape of..... 5										
8. Length of ear..... 10										
9. Circumference of ear.... 5										
10. Space— a. Furrows between rows... 5										
b. Space between kernels at cob..... 5										
11. Proportion of corn to cob 10										
Total .....100										

REASONS FOR CUTS

score obtainable for that point; then the others should be rated as they approach the standard fixed by this best sample. Thus, for the longest lint give two and a half points, and the same for the finest, also that showing the greatest degree of purity, and also for the greatest uniformity. Then as other samples fall short in any one or all these respects, cut accordingly.

This score card is not intended as a final and inflexible yardstick by which the merits of cotton of various types shall be measured throughout years to come, but rather as a temporary one to be used only until a better and more suitable one is suggested.

EXPLANATION OF POINTS IN CORN JUDGING

1. Trueness to type or breed characteristics; 10 points—The ten ears in the sample should possess similar or like characteristics and should be true to the variety which they represent.

2. Shape of ear; 10 points—The shape of the ear should conform to the variety type. Ears should be full and strong in central portion, and not taper too rapidly toward the tip, indicating strong constitution and good yield.

3. Purity of color: (a) Grain; five points—Color of grain should be true to variety and free from mixture. For one or two mixed kernels, a cut of one-fourth point; for four or more mixed kernels, a cut of one-half point should be made. Differences in shade of color, as light or dark red, white or cream color, must be scored according to variety characteristics. (b) Cob; five points—An ear with white cob in yellow corn or red cob in white corn should be disqualified or marked zero. This mixture reduces the value of the corn for seed purposes, indicates lack of purity, and tends toward a too wide variation in time of maturity, size and shape of kernels, etc.

4. Vitality or seed condition; 10 points—Corn should be in good market condition, show good constitution, being capable of producing strong, vigorous growth and yield.

5. Tips; five points—The form of tip should be regular; kernels near tip should be of regular shape and size. The proportion of tip covered or filled must be considered. Long

pointed tips, as well as blunt, flattened, or double tips, are objectionable.

6. Butts; five points—The rows of kernels should extend in regular order over the butt, leaving a deep depression when the shank is removed. Open and swelled butts, pressed and flat butts with flattened, glazed kernels, are objectionable and must be cut according to the judgment of the scorer.

7. Kernels: (a) uniformity of, 10 points; (b) shape of, five points—The kernels should be uniform in shape and size, making it possible to secure uniformity in dropping with the planter, and consequently a good stand. The kernels should also be not only uniform in individual ear, but uniform with each ear in the sample. They should be uniform in color and true to variety type. The kernels should be so shaped that their edges touch from tip to crown. The tip portion of the kernel is rich in protein and oil, and hence of high feeding value. Kernels with a large germ insure strong, vigorous growth as well as richness in quality of kernel.

8. Length of ear; 10 points—The length of ear varies according to variety type and the characteristics sought for by the individual breeder. Uniformity in length is to be sought for in a sample, and a sample having even lengths of ears should score higher than one that varies, even if it be within the limits. Usual lengths of ears, $8\frac{1}{2}$ to 12 inches. Very long ears are objectionable because they usually have poor butts and tips, broad shallow kernels, and hence a low percentage of corn to cob.

9. Circumference of ear; five points—The points made on length of ear, differing with variety types, hold true also in circumference of ear. The circumference of the ear should be in symmetry with its length. An ear too great in circumference for its length is generally slow in maturing, and too frequently results in soft corn. Dimensions should be from $6\frac{1}{2}$ to 9 inches in circumference. Measure the circumference at one-third the distance from the butt to the tip of the ear.

10. (a) Furrows between rows; five points—The furrows between the rows of kernels should be of sufficient size to permit the corn to dry out readily, but not so large as to lose proportion of corn to cob. (b) Space between tips of kernels at

cob; five points—This is very objectionable, as it indicates immaturity, weak constitution, and poor feeding value.

11. Proportion of corn to cob; 10 points—The proportion of corn is determined by weight. Depth of kernels, size of cob, maturity, furrows and space at cob, all affect the proportion. In determining the proportion of corn to cob, weigh and shell every alternate ear in exhibit. Weigh the cobs and subtract from weight of ears, giving weight of corn; divide the weight of corn by total weight of ears, which will give the per cent. of corn. Per cent. of corn should be from 86 to 87. For each per cent. short of standard a cut of $1\frac{1}{2}$ points should be made. Each sample should consist of ten ears of corn.

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ANIMAL INDUSTRY

Dairy Division

SANITARY INSPECTION OF CITY MILK PLANTS

Owner or manager:..... Trade name:

City:..... Street and No.:..... State:

Number of wagons :..... Gallons sold daily { Milk,.....
Cream,.....

Permit or license No.:..... Date of inspection:....., 190

	SCORE		REMARKS
	Perfect	Allowed	
MILK ROOM			
Location.....	10		
Construction—	10		
Floor (3).....			
Walls and ceiling (3)			
Drainage (4).....			
Cleanliness.....	15		
Light and ventilation.....	10		
Equipment—	15		
Arrangement (3).....			
Construction—			
Sanitary (2).....	15		
Durability (2).....			
Condition (3).....			
Cleanliness (5).....			
MILK			
Handling (12).....	20		
Storage (8).....			
SALES ROOM			
Location (2).....	10		
Construction (2).....			
Equipment (2).....			
Cleanliness (4).....			
WAGONS			
General appearance (2).....	10		
Protection of product (3).....			
Cleanliness (5).....			
Total.....	100		

Sanitary conditions are—Excellent :..... Good :..... Fair :..... Poor :

Suggestions by inspector :.....

Signed :.....
Inspector.

WAGONS

GENERAL APPEARANCE.—If painted and in good repair, allow 2 points; for fair condition, 1; poor, 0.

PROTECTION OF PRODUCT.—If product is iced, allow 3 points; well protected but not iced, 1; no protection, 0.

CLEANLINESS.—If perfectly clean, allow 5; good, 3; fair, 2; poor, 0.

DIRECTIONS FOR SCORING

FLAVOR

If rich, sweet, clean, and pleasant flavor and odor, score perfect (40). Deduct for objectionable flavors and odors according to conditions found.

COMPOSITION

If 20 per cent. fat or above, score perfect (25). Deduct 1 point for each $\frac{1}{2}$ per cent. fat below 20.

BACTERIA

Less than 10,000 per cubic centimeter.....20 (perfect).

Over 10,000 and less than 25,000 per cubic centimeter..... 19

Over 25,000 and less than 50,000 per cubic centimeter..... 18

Over 50,000 and less than 75,000 per cubic centimeter..... 17

Over 75,000 and less than 100,000 per cubic centimeter..... 16

Deduct 1 point for each 25,000 above 100,000.

When an unusually large number of liquefying bacteria are present, further deduction should be made according to conditions found.

ACIDITY

If 0.2 per cent. or below, score perfect (5). Deduct 1 point for each 0.01 per cent. above 0.2. (If Mann's test is used, discontinue adding indicator on first appearance of a pink color.)

APPEARANCE OF PACKAGE AND CONTENTS

If package is clean, free from metal parts, and no foreign matter can be detected in the contents, and physical condition of product is good, score perfect (10). Make deductions according to conditions.

DIRECTIONS FOR SCORING

COWS

CONDITION.—Allow 2 if in good flesh. Deduct according to conditions.

HEALTH.—Allow 2 if apparently healthy. Deduct for indications of disease.

COMFORT.—Allow 2 for good conditions. Deduct 1 for poor (a)* or no bedding (b) and 1 if left too long in cold outside (c) or inside (d) of stable.

VENTILATION.—Allow 4 for good system—King or muslin curtain (a)—2 for windows inclining inward at top (b), 1 for sliding windows (c), and nothing for holes in ceiling (d).

CUBIC SPACE PER COW.—Allow 3 if 500 to 1,000 cubic feet per cow, 2 for less than 500 and over 400, 1 for less than 400 and over 300. For less than 300, 0. Deduct 1 for each 500 cubic feet over 1,000 under winter conditions.

*The letters a, b, c, etc., should be entered on score card to show condition of dairy, and when so entered should always indicate a deficiency.

CLEANLINESS.—Allow 5 if perfect. Deduct according to conditions.

FOOD.—Allow 2 if good. Deduct for anything musty or decomposed.

WATER.—Allow 4 for clean running water in trough NEAR stable (a) and 3 for same INSIDE stable (b); deduct for running water DISTANT from stable according to distance (c); deduct 1 for still water or water pumped by hand (d). (Water from windmill tanks under good conditions will be considered as running water.)

STABLES

LOCATION.—Allow 3 if used for no other purpose (a), conveniently located (b), on well-drained ground (c), with yard protected from cold winds (d). Deduct 3 if horses, swine, or poultry are kept in stable. Deduct 1 if poultry are allowed in stable during day.

CONSTRUCTION.—Allow $1\frac{1}{2}$ for floor of good cement (a) or equally good material (b) in good condition (c); good wood floor 1 (d); properly constructed gutter $\frac{1}{2}$ (e); good stall (f); swinging stanchion (g) or good tie $\frac{1}{2}$ (h); smooth tight ceiling $\frac{1}{2}$ (i); ceiling proper height $\frac{1}{2}$ (j); side walls smooth and tight $\frac{1}{2}$ (k); convenient box stall $\frac{1}{2}$ (l); good low-down manger $\frac{1}{2}$ (m).

CLEANLINESS.—Allow 4 for a washed floor (a), 2 if well swept (b), and 1 if well scraped (c). Allow 1 for clean side walls (d), 1 for clean windows (e), and 1 for clean ceilings and ledges (f).

LIGHT.—Allow 5 for four square feet of unobstructed glass per stanchion or stall (a) and evenly distributed (b). Deduct $\frac{1}{2}$ point for each square foot less than four; deduct 2 for uneven distribution of light, not exceeding 2 points.

STABLE AIR.—Allow 2 if free from dust and odors at time of milking. Deduct according to conditions.

REMOVAL OF MANURE.—Allow 2 if removed daily to field or to proper pit giving off no odor to stable. Deduct 1 if removed to yard and over 30 feet from stable; otherwise allow 0.

STABLE YARD.—Allow $\frac{1}{2}$ point if clean (a), and $\frac{1}{2}$ point if well drained (b).

MILK HOUSE AND STORAGE

LOCATION.—Allow 2 if conveniently located (a), away from hog pen (b), privy (c), or other source of contamination (d). Deduct 1 for no clear air space between stable and milk room.

CONSTRUCTION.—Allow 2 for tight, sound floor (a), walls and ceiling (b), well lighted (c), well ventilated (d), and free from flies (e).

EQUIPMENT.—Allow 1 point for hot water or steam for cleansing utensils (a); $\frac{1}{2}$ point for cooler in good condition (b); 1 for proper narrow-top milk pail (c); $\frac{1}{2}$ point for general utensils properly constructed (d).

CLEANLINESS.—Allow 3 if interior is clean. Deduct according to conditions.

UTENSILS.—Allow 3 if clean (a); 2 for proper care (b) (inverted in pure air). Otherwise, 0.

WATER SUPPLY FOR CLEANING.—Allow 5 if abundant, convenient, and pure. Deduct according to conditions.

STORAGE.—Allow 5 if stored at 50° F. or below; over 50° and not over 55° F., 4; over 55° and not over 60° F., 3; over 60° F., 0.

MILKING AND HANDLING MILK

CLEANLINESS OF MILKING.—Allow 3 for clean suits used only for milking (a) and kept in a clean place when not in use (b). Allow 4 for washing udders and teats and wiping them with a clean towel (c); 2 if wiped with moist cloth only (d); 1 if wiped with clean, dry cloth (e); 0 if cleaning is done after milker sits down to milk or if no attention is given. Allow 3 if milking is done with clean, dry hands.

PROMPT AND EFFICIENT COOLING.—Allow 5 if cooled immediately after each cow is milked. Allow 5 if cooled to 50° F. or below; over 50° and not over 55° F., 4; over 55° and not over 60° F., 3; over 60° F., 0.

PROTECTION DURING TRANSPORTATION.—Allow 5 if iced and covered; 4 if cans are jacketed or covered with clean, wet blanket; 2 for dry blanket. If no protection, 0.

UNITED STATES DEPARTMENT OF AGRICULTURE

BUREAU OF ANIMAL INDUSTRY

Dairy Division

SANITARY INSPECTION OF DAIRIES

DAIRY SCORE CARD

Owner or lessee of farm :
 Town : State :
 Total No. of cows : No. milking : Quarts of milk produced daily :
 Product is sold at wholesale—retail. Name and address of dealer to whom shipped :
 Permit No. Date of inspection :, 190

	SCORE		REMARKS
	Perfect	Allowed	
COWS			
Condition	2	.....	.....
Health : Outward appearance	3	.....	.....
Comfort	2	.....	.....
Ventilation.....	4	.....	.....
Cubic space.....	3	.....	.....
Cleanliness.....	5	.....	.....
Food	2	.....	.....
Water	4	.....	.....
Total.....	25	.....	Per cent. perfect.....
STABLES			
Location.....	3	.....	.....
Construction.....	5	.....	.....
Cleanliness	7	.....	.....
Light.....	5	.....	.....
Stable air	2	.....	.....
Removal of manure.....	2	.....	.....
Stable yard.....	1	.....	.....
Total	25	.....	Per cent. perfect.....
MILK HOUSE AND STORAGE			
Location.....	2	.....	.....
Construction.....	2	.....	.....
Equipment.....	3	.....	.....
Cleanliness.....	3	.....	.....
Care and cleanliness of utensils.....	5	.....	.....
Water supply for cleaning.....	5	.....	.....
Storing at low temperature.....	5	.....	.....
Total.....	25	.....	Per cent. perfect.....
MILKING AND HANDLING MILK			
Cleanliness of milking.....	10	.....	.....
Prompt and efficient cooling.....	10	.....	.....
Protection during transportation.....	5	.....	.....
Total	25	.....	Per cent. perfect.....
Total	100	.....	.....

QUESTION 1. Has the herd passed the tuberculin test within a year? Yes. No.

QUESTION 2. Has the water supply been examined for contamination? Yes. No.

QUESTION 3. Is there any case of contagious disease on the farm that is not properly isolated? Yes. No.

Signed : Inspector.

NOTE.—If conditions are so exceptionally bad in any particular as to be inadequately expressed by a score of 0 the inspector will write BAD in the column of Remarks, opposite the 0.

**UNITED STATES DEPARTMENT OF AGRICULTURE
BUREAU OF ANIMAL INDUSTRY**

DAIRY DIVISION

SCORE CARD FOR MARKET CREAM

Exhibitor

Address

NUMERICAL SCORE

Flavor, 40	Composition, 25	Bacteria, 20	Acidity, 5	Appearance of package and contents, 10	Perfect score, 100
					Judge's score

DESCRIPTIVE SCORE

Flavor	Composition	Bacteria	Acidity	Package and Contents
Excellent	Perfect	Perfect	Perfect	Perfect
Good	Fat...per cent.	Total.....	.....per cent.	Foreign matter
Fair		Liquefiers.....		Metal parts
Bad				Unattractive
.....				Lumpy
Flat				Frothy
Bitter				
Weedy				
Garlic				
Silage				
Smothered				
Manure				
Other taints				
.....				
.....				

Remarks

Date

(Signature)
Judge.

DIRECTIONS FOR SCORING

MILK ROOM

LOCATION.—If not connected by door with any other building, and surroundings are good, 10; when connected with other rooms, such as kitchens, stables, etc., make deductions according to conditions.

CONSTRUCTION.—If good cement floor, and tight, smooth walls and ceiling, and good drainage, allow 10; deduct for cracked or decayed floors, imperfect wall and ceiling, etc.

CLEANLINESS.—If perfectly clean throughout, allow 15; deduct for bad odors, unclean floor and walls, cobwebs, unnecessary articles stored in room, etc.

LIGHT AND VENTILATION.—If window space is equivalent to 15 per cent. or more of the floor space, allow 5; deduct 1 point for every 3 per cent. less than the above amount.

EQUIPMENT:

Arrangement.—Allow 3 points for good arrangement; if some of the equipment is out of doors or so placed that it cannot be readily cleaned, make deductions according to circumstances.

Condition.—If in good repair, allow 4 points; make deductions for rusty, worn-out, or damaged apparatus.

Construction—

Sanitary: If seams are smooth, and all parts can be readily cleaned, allow 2. Deduct for poor construction, from sanitary standpoint.

Durability: If made strong and of good material, allow 2. Deduct for light construction and poor material.

Cleanliness.—If perfectly clean, allow 8 points; make deductions according to amount of apparatus improperly cleaned.

MILK

HANDLING.—If milk is promptly cooled to 50° F. or lower, allow 12 points; or if pasteurized at a temperature of 149° F. or above and promptly cooled to 50° or lower, allow 12 points. Deduct 1 point for every 2° above 50°. If milk is pasteurized imperfectly, deduct 6 points. If milk is improperly bottled or otherwise poorly handled, make deductions accordingly.

STORAGE.—If stored at a temperature of 45° F. or below, allow 8 points. Deduct 1 point for every 2° above 45°.

SALES ROOM

LOCATION.—If exterior surroundings are good and building is not connected with any other under undesirable conditions, allow 2; for fair conditions allow 1; poor conditions, 0.

CONSTRUCTION.—If constructed of material that can be kept clean and sanitary, allow 2; for fair construction allow 1; poor construction, 0.

EQUIPMENT.—If well equipped with everything necessary for the trade, allow 2; fair equipment, 1; poor equipment, 0.

CLEANLINESS.—If perfectly clean, allow 4 points; if conditions are good, 2; fair, 1; poor, 0.



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